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ABSTRACT

Hiding Information in Electoral Competition

by Paul Heidhues and Johan Lagerlöf*

We model a two-candidate electoral competition in which there is uncertainty about a policy-relevant state of the world. The candidates receive private signals about the true state, which are imperfectly correlated. We study whether the candidates are able to credibly communicate their information to voters through their choice of policy platforms. Our results show that the fact that private information is dispersed between the candidates creates a strong incentive for them to bias their messages toward the electorate's prior. Information transmission becomes more difficult, the more the information is dispersed between the candidates and the stronger is the electorate's prior. Indeed, as more prior information becomes available, welfare can *decrease*.

Keywords: Electoral competition; Opportunism; Information aggregation; Cheap talk.
JEL classification: D72, D78, D82

ZUSAMMENFASSUNG

Verheimlichen von Informationen im Wahlkampf

In diesem Beitrag wird ein Wahlkampf zwischen zwei Politikern modelliert, in welchem Unsicherheit über die bessere von zwei Politikalternativen herrscht. Die Kandidaten erhalten private und unvollständig korrelierte Signale darüber, welche Politik für die Wähler besser ist. Der Beitrag untersucht, ob die Kandidaten diese Informationen durch die Auswahl ihrer Wahlkampfplattform glaubwürdig an die Wähler weitergeben können. Die Tatsache, dass die Kandidaten nicht *genau* dieselben Information haben, führt dazu, dass sie ihre Informationen teilweise oder völlig ignorieren und ihre Wahlkampfplattform in Richtung der a priori Informationen der Wähler ausrichten. Die Weitergabe der Informationen der Politiker wird umso schwieriger desto mehr die Informationen zwischen den Kandidaten verteilt sind und desto besser die Wähler informiert sind. Im Gleichgewicht kann dies sogar dazu führen, dass bessere a priori Informationen der Wähler die Wohlfahrt *senken*.

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1 Introduction

An important and much debated question in political economy is whether democracies produce efficient results. The school of thought often associated with the University of Chicago contends that, because of competition for votes between political parties or candidates, public policy will indeed be efficient: if a politician implemented an inefficient policy, he would be voted out of office (see e.g. Wittman 1989). The "Virginia School" of political economy, in contrast, argues that voters typically have imperfect information about the effects of different policies and, therefore, politicians are able to select policies that are inefficient. Moreover, although the voters would gain if they knew more about the effects of the different policies and thereby were better able to control the politicians, the voters will remain rationally ignorant; that is, since the probability that an individual voter will affect the outcome of an election is very small, she will not acquire costly information about the political alternatives. While Wittman (1989) agrees that voters may initially not be well informed about political markets, he argues that competition between political candidates also eliminates this problem: "The arguments made for the voter's being uninformed implicitly assume that the major cost of information falls on the voter. However, there are returns to an informed political entrepreneur from providing the information to the voters, winning office, and gaining the direct and indirect rewards of holding office" (p. 1400).

Wittman's argument raises the question how a political entrepreneur who tries to transmit information to the electorate can do this without facing a severe credibility problem. How does the entrepreneur convince the voters that he, when making statements and choosing his electoral platform, indeed pursues the electorate's — rather than his own — goals? Presumably the goals of the entrepreneur include winning office, and succeeding in this should be at least as important for him as implementing some particular policy. In this paper we argue that information transmission from political candidates to voters is indeed very difficult. In particular we argue that candidates have a strong incentive to follow popular beliefs (i.e., the voters' prior) instead of their own information.

Why, then, do popular beliefs have such a strong drawing power? Our argument goes as follows. When the political entrepreneur considers what policy suggestion to make to the voters, he should anticipate that his competitors may also have access to private information about which policy is the best one for the voters — and that the voters, too, are aware of this. Hence, the entrepreneur knows that, in order to win the election, he must convince the electorate that *his* policy suggestion — and not the ones of the other candidates — is the one that is most likely to lead to the preferred outcome. This means, in particular, that the entrepreneur should not be truthful to the electorate when his private information goes against the voters' prior beliefs. For if a competing candidate were to suggest a policy that is more in line with the electorate's prior beliefs, the entrepreneur will have a hard time convincing the voters that his information should have a heavier weight than their prior and the other candidate's information taken together. The dilemma for the voters, however, is that information that differs from the prior is precisely the kind of information that would be useful for them.

Hence, the source of the difficulty in transmitting information to the voters is that information is dispersed among the political candidates: they do not have access to exactly the same pieces of information. The reason for this, we believe, is that candidates do not typically get their information from exactly the same sources. For instance, we should expect the candidates to get at least part of their information through personal experiences. Moreover, when consulting experts, different candidates often consult different experts. This presumption of ours that politicians as a group are better informed than each politician individually has a parallel in the literature on the so-called Condorcet jury theorem (see Piketty 1999 and the references therein). This literature assumes that policy-relevant information is dispersed among *voters* rather than candidates, and it investigates whether the information can be aggregated in a voting procedure.[1]

In the model that we develop in this paper there are two political candidates who run for office. Both of them have some private information about which policy is the best one for the electorate, and the noisy signals that the candidates observe are, conditionally on the true state, independent. The policy space (as

[1] We believe that, in many real-world situations, our assumption is at least as reasonable as the one in the literature on the Condorcet jury theorem. We therefore consider our paper as complementary to that literature. To the best of our knowledge, there is no other paper that assumes that information about which policy is the best one is dispersed among politicians.

well as the signal space) is for simplicity assumed to be binary: the alternatives between which society must choose are "building a bridge" (B) and "not building a bridge" (N). A key assumption is that the electorate's prior beliefs are such that one of the policies (B) is more likely than the other to be the best one. Prior to the election the candidates, who are office-motivated, simultaneously announce policy platforms. After having observed the announced platforms but not the candidates' private signals, the members of the electorate vote for one of the candidates. Finally the winning candidate takes office and implements his announced platform.

From a welfare point of view, the most desirable behavior on the part of the candidates would be if they revealed all their private information by always choosing platform B if having observed a signal in favor of B, and platform N if having observed a signal in favor of N. We show, however, that this behavior cannot be part of a (perfect Bayesian) equilibrium.[2] Indeed, within the family of equilibria in which the candidates do not randomize in their platform choices, the only equilibria that survive a reasonable equilibrium selection criterion[3] are babbling (i.e., no information at all can be inferred from the candidates' behavior): either the candidates always choose platform B (the **popular-beliefs equilibria**) or they always choose platform N. The latter equilibria are Pareto-dominated by the former, however, and we therefore conclude that, within this family of equilibria, the outcome associated with the popular-beliefs equilibria is the more reasonable prediction.

The result that popular beliefs have a strong drawing power also holds qualitatively when we consider equilibria in which the candidates are not constrained

[2] Perhaps somewhat surprisingly, it turns out that there always exist another kind of fully revealing equilibria of this model. In these equilibria, however, having access to the candidates' information is not useful for the electorate. The reason for this is the way by which one of the candidates reveals his information: he consistently chooses the policy that his signal indicates he should **not** choose; as a consequence, this candidate always loses the election. We can thus make a distinction between the issue of whether information can be credibly transmitted and the issue whether this is desirable from the point of view of the electorate's expected welfare. Indeed, we provide an example where a fully revealing equilibrium co-exists with a "babbling" equilibrium, and where the electorate's expected utility is higher in the latter, i.e., when no information at all can be inferred from the candidates' chosen platforms. Besley and Pande (1998) make a similar point by showing that, in their model, the absence of full information revelation does not necessarily imply Pareto inefficiency.

[3] This criterion requires that, if the chosen platform configuration is such that the members of the electorate are indifferent between the candidates, both of them win with positive probability. In footnote 19 we provide a justification for this assumption.

to play pure strategies.[4] Again disregarding equilibrium outcomes that are Pareto-dominated by other equilibrium outcomes, we get the following unique prediction of our model: when information is sufficiently much dispersed between the candidates, then the candidates follow popular beliefs (with probability one); and when the candidates' signals are sufficiently much (unconditionally) correlated, then a mixed equilibrium is played in which the candidates' behavior is distorted toward popular beliefs. For the subset of the parameter space where the mixed equilibrium is played, we obtain the following comparative statics result. First, information transmission becomes more difficult the more the information is dispersed between the candidates. Second, information transmission also becomes more difficult the larger is the prior probability that B is the best policy (i.e., the stronger are the popular beliefs). Finally, welfare decreases in some interval as popular beliefs becomes stronger.[5] The reason for the last result is that the presence of the additional (prior) information distorts the candidates' incentives to reveal the information in their signals truthfully.[6] In particular, more prior information will be bad for welfare when the prior is sufficiently imprecise or, equivalently, when the candidates' signals are sufficiently accurate. In fact, when the candidates are very competent in the sense that their signals are very likely to be correct, more prior information is almost always bad for welfare.

At the end of the paper we briefly discuss what our results may imply for the candidates' incentives to acquire information and for other economic agents' incentives to provide information to the candidates.[7] First, the result that the

[4] Within our model, it is natural to consider mixed strategies on the part of the candidates. For if we allow the candidates to randomize, it is conceivable that they will be able to transmit more information than otherwise, since then (and only then) will they be able to choose the amount of noise in their messages continuously and endogenously; see our discussion in subsection 4.2.

[5] Harrington (1993) develops an innovative and non-standard electoral-competition model in which an incumbent president has an incentive to bias his policy toward popular beliefs. Harrington assumes that voters and candidates have different beliefs as to what is the best policy. The median voter prefers a candidate who believes in the same policy as she does. If the incumbent's beliefs differ from the median voter's, then the incumbent has an incentive to hide his type in order to increase his chance of being reelected. In Harrington's model one cannot investigate the information transmission problem, which is the focus of the current paper, since no player has an incentive to learn the other players' information. In addition, no meaningful welfare analysis is possible because which policy should be chosen is simply a question of opinion.

[6] This particular reason why access to more information can be detrimental to an economic agent has not, to our knowledge, been recognized previously in the literature. For other reasons why more information can be bad, see Lagerlöf (2000) and references therein.

[7] The model that we develop may also be used to explain the so-called incumbency ad-

candidates' behavior is very much guided by their beliefs about popular opinion suggests that they should have an incentive to acquire information about the electorate's beliefs rather than about the policy-relevant state of the world. Indeed, in the real world we often observe that political parties commission public opinion polls. Second, the result that policy platforms typically reflect popular opinion rather than the candidates' information about the true state suggests that interest groups may well prefer to address the electorate rather than the candidates in their lobbying activities.

The question whether information can be credibly transmitted from politicians to voters has been addressed in some other papers, too.[8] These papers have also identified reasons why we should, under particular circumstances, expect such information transmission to be difficult. This related literature, however, has focused on mechanisms that are different from the one investigated in the present paper — that is, the go-for-the-prior incentive of the candidates that arises whenever the two candidates do not have exactly the same information. The reason why this obstacle to credible information transmission does not appear in the previous papers is that these assume that either only one of the candidates has private information or that both candidates have exactly the same private information. Our paper can, therefore, be thought of as complementary to this literature.

The paper that is perhaps most closely related to ours is Schultz (1996). He shows that whenever two political parties are sufficiently much polarized — in the sense that their policy preferences are sufficiently much different from the median voter's — the parties will have an incentive to misrepresent their information in order to increase their chances of winning office and thereby being able to implement their own favorite policy. A similar effect is present in

vantage, i.e., the empirical observation that incumbent candidates (or governments) are more likely than their challengers to win elections. For there exist equilibria of our model in which the electorate can learn the content of one signal; in these equilibria, one of the candidates (who we can think of as the incumbent) wins with probability one. In contrast, in any equilibrium in which both candidates win with positive probability the electorate learns an amount of information that corresponds to less than one signal. Hence, by simply ignoring one of the candidates and instead vote for the other one of them (who, because of focality reasons, conceivably could be the incumbent), the electorate can provide this incumbent with an incentive to truthfully reveal all his information to the electorate. This explanation of the incumbency advantage, however, is not consistent with our equilibrium selection criterion mentioned in footnote 3.

[8] See, for example, Besley and Pande (1998), Cukierman and Tommasi (1998), Letterie and Swank (1998), Martinelli (1998), Roemer (1994), and Schultz (1995, 1996, 1999).

Cukierman and Tommasi (1998). They show that, because of the credibility problem, a typical left-wing policy may be easier to implement by a right-wing politician (and vice versa), and it therefore "takes a Nixon to go to China." Another recent paper that is related to ours, although it does not model an electoral competition, is Besley and Pande (1998). They show that a politician's incentive to redistribute income ex post can make it impossible for him to communicate to the citizens what he knows about the profitability of different private investment alternatives.

The phenomenon in our model that political candidates behave opportunistically and follow the electorate's prior instead of their own information makes it similar to papers by Prendergast (1993) on "yes men" and by Morris (1999) on political correctness. The yes men in Prendergast's principal-agent model distort their messages toward the principal's prior because their performance is evaluated using the principal's opinion as a benchmark. This kind of incentive contract can be optimal for the principal since she wants to induce the agent to make an effort and she cannot make the contract contingent on the true state. In Morris's model of political correctness, a decision maker is consulting an advisor who may be either "good" (i.e., with identical preferences to the decision maker) or "bad" (i.e., biased in favor of a particular decision). Since an advisor wants to be consulted also in later periods in order to influence future policy, he is anxious not to be perceived as a bad advisor. Because of these instrumental reputational concerns, he may have an incentive to initially bias his advice away from the bad advisor's preferred policy.

Our model is also related, more generally, to other work on strategic information transmission. As in Crawford and Sobel's (1982) model of cheap talk, sending messages in our model (i.e., choosing platforms) has no cost to the candidates other than that inherent in the electorate's choice of action, since our candidates are solely office-motivated. In their model of expert advice, Krishna and Morgan (1998) extend the Crawford and Sobel setting by assuming that there are **two** senders who act sequentially and who both know the true state. They show that having two senders instead of only one can actually decrease the amount of information transmitted — a result which is in the spirit of ours although driven by other assumptions. The Krishna and Morgan paper and several other recent models of expert advice[9] differ from our setting in at least two important regards. First, our "experts" (i.e., candidates) care intrinsically about whether their "advice" is followed or not (i.e., whether they get elected). In the cited literature, in contrast, experts care either about the policy they advice on or about the decision maker's perception of their competence. Second, the advice provided by the experts in our model has a real effect in that it determines the action set available to the decision maker. In our application, which concerns an electoral competition, we believe our setup to be very natural.

The remainder of the paper is organized as follows. In the next section we describe a relatively simple model that captures our argument. Section 3 considers some useful benchmarks. In Section 4 our main model is analyzed and the results are presented. Section 5 summarizes and discusses our main results. Most of the proofs are found in an appendix.

2 The Model

Consider the following model of an election with two candidates and one representative voter. There are two policy alternatives, B and N, and two states of the world, ω_B and ω_N. For the sake of concreteness we can think of policy B as "building a bridge" and policy N as "not building a bridge"; the states of the world can be thought of as "the costs of building a bridge will be modest" (ω_B) and as "building a bridge will be very costly" (ω_N). The voter wants the bridge to be built if and only if the costs will be modest. More precisely, given a policy $x \in \{B, N\}$ and a state $\omega \in \{\omega_B, \omega_N\}$, the voter's payoff function $u(x, \omega)$ is such that $u(B, \omega_B) = u(N, \omega_N) = 1$ and $u(B, \omega_N) = u(N, \omega_B) = 0$. It is also assumed that the prior distribution of the state is in favor of policy B, $\Pr(\omega = \omega_B) \equiv q \in \left(\frac{1}{2}, 1\right)$. That is, if the prior is the only information that is available, the best policy from the voter's point of view is to build the bridge.

The two political candidates are labeled 1 and 2. We adopt the standard Downsian assumption that they are only office motivated: candidate i's (where $i \in \{1, 2\}$) payoff if he wins the election is 1, and 0 otherwise. We also assume, again in keeping with the Downsian framework, that the candidates precommit to electoral platforms. More exactly, the sequence of events is as follows. First

[9] See, for example, Ottaviani and Sørensen (1999a, b) and Battaglini (2000).

each one of the two candidates privately observes a noisy signal $s_i \in \{B, N\}$ about the true state ω. Second, conditional upon his signal s_i, each candidate chooses an electoral platform $x_i \in \{B, N\}$; the candidates do this simultaneously. Finally the voter observes the candidates' chosen platforms x_1 and x_2 and then chooses for whom to vote. The candidate who gets the vote wins office and implements his previously chosen policy.

The signal technology works as follows. The probability of receiving a signal s_i in state ω is given by

$$\Pr(s_i = j \mid \omega = \omega_k) = \begin{cases} 1-\varepsilon & \text{for } j = k \\ \varepsilon & \text{for } j \neq k, \end{cases} \tag{1}$$

where $j, k \in \{B, N\}$ and $\varepsilon \in \left(0, \frac{1}{2}\right)$. Hence, $(1-\varepsilon)$ is the probability of receiving a "correct" signal. Given the state ω, the signals s_1 and s_2 are independent. Notice that in this formulation of the signal technology it is implicitly assumed that the quality of the candidates' signals are the same.

Let σ_i^j denote the probability that candidate $i \in \{1, 2\}$ chooses platform B after having observed a signal $j \in \{B, N\}$; and let σ_3^{jk} denote the probability with which the voter elects candidate 1 when having observed the platform configuration $(x_1, x_2) = (j, k)$, for $(j, k) \in \{B, N\}^2$. We also let

$$\sigma = \left(\sigma_1^B, \sigma_1^N; \sigma_2^B, \sigma_2^N; \sigma_3^{BB}, \sigma_3^{BN}, \sigma_3^{NB}, \sigma_3^{NN}\right) \tag{2}$$

denote a vector of (behavioral) strategies of the three players.

The equilibrium concept that we employ is that of perfect Bayesian equilibrium, where this equilibrium concept is defined in the usual way: all three players must make optimal choices at all information sets given their beliefs, and the beliefs are formed using Bayes' rule when that is defined. For the sake of brevity we will refer to a perfect Bayesian equilibrium simply as an equilibrium.

In the subsequent analysis we investigate, among other things, how much of the candidates' private information is revealed to the voter. Hence, the following definitions will be useful. A candidate **fully reveals** his signal if he chooses different platforms for each one of the possible realizations of his signal. A candidate **simply announces** his signal if his platform choice is identical to his signal. A candidate **babbles** if his platform choice is independent of his signal.[10]

[10] Formally, we say that candidate i fully reveals his signal if $\sigma_i^B \in \{0, 1\}$ and $\sigma_i^N = 1 - \sigma_i^B$; candidate i simply announces his signal if $\sigma_i^B = 1$ and $\sigma_i^N = 0$; and candidate i babbles if $\sigma_i^B = \sigma_i^N$.

Thus, a natural taxonomy to describe different kinds of possible equilibria is the following: in a fully revealing equilibrium both candidates fully reveal their signals. Hence, in such an equilibrium the voter can infer the contents of both candidates' signals perfectly. In a babbling equilibrium both candidates babble, which means that the voter cannot infer any information. The remaining case is a partially revealing equilibrium. In such an equilibrium the voter can infer some — but not all — of the information contained in the candidates' signals.

3 Some Observations and Benchmarks

As mentioned in the previous section, we assume that when the voter only knows the prior, her belief is that policy B is the best one ($q > 1/2$). Before solving for the equilibria of the model, it will be useful to investigate how the voter would change her beliefs about which policy is the best one if she were able to infer the signal of one of the candidates and if she were able to infer both candidates' signals. First, suppose the voter knew the content of exactly one of the signals. Then, if this signal indicated that B is the best policy, the voter would of course still prefer policy B, since her prior also favors this policy. If the signal indicated that policy N is the best policy, then the voter would change her mind and prefer policy N only if the probability of a correct signal is larger than the prior probability that B is the best policy: $1 - \varepsilon > q$;[11] if this inequality were reversed, the voter would still prefer policy B.

Second, suppose the voter knew the content of both signals. Then, if both indicated policy B, the voter would of course still prefer policy B. Similarly, if one signal were in favor of B and the other in favor of N, the voter would again still prefer policy B, since the signals are of the same quality and thus their informational content would cancel out. If both signals indicated policy N, then the voter would prefer policy N only if the prior probability that B is the best policy is not too large:[12]

$$q < \frac{(1-\varepsilon)^2}{1 - 2\varepsilon(1-\varepsilon)} \equiv \widetilde{q}. \tag{3}$$

If this inequality were reversed, the voter would still prefer policy B even after

[11] One can check this formally by using Bayes' rule.
[12] Again, this expression can be derived by using Bayes' rule.

having observed two signals indicating N. Since this would not make for an interesting problem, we assume that $q \in (1/2, \widetilde{q})$ throughout the analysis.

Let us now look at a welfare benchmark in which a planner who maximizes the voter's expected utility can dictate to the two candidates which platform to choose as a function of that candidate's signal. The voter then, just as in our main model, updates her beliefs given the observed platforms and elects the candidate who will give her the highest expected utility given her updated beliefs. That is, the outcome of this welfare benchmark is simply the outcome that is first best from the voter's point of view. The best thing the planner can do is to let each candidate choose platform B if having observed a signal B, and platform N if having observed a signal N. This means that the voter will, if the candidates' platforms differ, elect the candidate who has chosen platform B; if the platforms are identical, then it does not matter who she elects.

Let us denote the voter's expected utility in this benchmark by EU_{BM}. We get

$$\begin{aligned} EU_{BM} &= \Pr(\omega = \omega_B) \Pr(\text{Either } s_1 = B \text{ or } s_2 = B \mid \omega = \omega_B) \\ &\quad + \Pr(\omega = \omega_N) \Pr(\text{Both } s_1 = N \text{ and } s_2 = N \mid \omega = \omega_N) \\ &= q \left[(1-\varepsilon)^2 + 2\varepsilon(1-\varepsilon) \right] + (1-q) \left[(1-\varepsilon)^2 \right] \\ &= (1-\varepsilon)\left[1 + \varepsilon(2q-1)\right]. \end{aligned} \tag{4}$$

Figure 1 illustrates how the expected utility EU_{BM} varies with the prior q. The graph of the function EU_{BM} is depicted in the figure as the upper straight line; for $q = 1/2$ the function takes the value $(1-\varepsilon)$ and for $q = \widetilde{q}$ it takes the value $\widetilde{q}$ (recall that we have assumed $q \in (1/2, \widetilde{q})$). The expected utility EU_{BM} forms a useful benchmark since it gives us an upper bound on the level of expected utility that may be realized in any equilibrium.

Finally in this section we will investigate two positive benchmarks in which the assumptions of our main model are slightly altered. Doing this will help us understand exactly what features of the model drive the results that we will derive later. First we consider a benchmark where both candidates have access to exactly the same information but which is otherwise identical to the model described in Section 2. That is, here the candidates both observe one (and the same) signal, and the content of this signal is unobservable to the voter. We make the following observation.

Observation 1 (Identical Signals). *Consider a benchmark model where the candidates observe the same signal. Suppose that* $q \in \left(\frac{1}{2}, 1-\varepsilon\right]$. *Then we can sustain an equilibrium where* $\sigma = (1,0;1,0;\sigma_3,\sigma_3,\sigma_3,\sigma_3)$ *for any* $\sigma_3 \in [0,1]$.

That is, if the candidates have access to exactly the same information (and if this is common knowledge among the players), then there exists a fully revealing equilibrium in which the candidates simply announce their signals. To see that the claim in Observation 1 is true, notice that since the candidates win the election with the same probability for all platform configurations, none of them will have an incentive to deviate. Moreover, the voter observes different platforms only off the equilibrium path. It is easy to check that, for $q \in \left(\frac{1}{2}, 1-\varepsilon\right]$,[13] the voter's behavior is optimal at all her information sets given some out-of-equilibrium beliefs. For $\sigma_3 \in (0,1)$, the requirement on these beliefs off the equilibrium path is that the voter thinks that a candidate who has chosen a platform B is, to some extent, more likely to have deviated than the candidate who has chosen platform N.

Finally we consider a benchmark where there are no popular beliefs, that is, where $q = 1/2$. Here we make the following observation.

Observation 2 (No Popular Beliefs). *Suppose that* $q = 1/2$. *Then we can sustain an equilibrium where* $\sigma = (1,0;1,0;\sigma_3,\sigma_3,\sigma_3,\sigma_3)$ *for any* $\sigma_3 \in [0,1]$.

That is, if there are no popular beliefs, then again a fully revealing equilibrium exists in which the candidates simply announce their signals. To see that the claim in Observation 2 is true, notice that since the candidates win the election with the same probability for all platform configurations, none of them will have an incentive to deviate. Moreover, if it turns out that the candidates have chosen different platforms, then the voter can infer that one of them received a signal in favor of B while the other received a signal in favor of N. Since

[13] Remember that in this benchmark the candidates observe only one signal. Thus, for $q > 1-\varepsilon$, the voter prefers platform B regardless of which signal the candidates received. In other words, a fully revealing equilibrium exists whenever this benefits the voter.

the quality of the signals is the same, the informational value of the two signals will cancel out and the voter's updated beliefs are identical to her prior beliefs, Thus, the voter is always indifferent between the candidates.

4 Equilibrium Behavior

We will now return to the main model described in Section 2. First we solve for equilibria of that model in which both candidates (at both their information sets) choose pure strategies (subsection 4.1). After that we investigate equilibria in which at least one of the candidates (at at least one of his information sets) is randomizing between the platforms (subsection 4.2).

4.1 Candidates' Playing Pure

A candidate who plays pure[14] must be either babbling or fully revealing the content of his signal. We start with considering existence of equilibria in which both candidates fully reveal their signals.

Proposition 1. (Full Revelation) *Fully revealing equilibria exist. A strategy profile σ is part of a fully revealing equilibrium if and only if $\sigma = (1,0;0,1;1,1,1,1)$ or $\sigma = (0,1;1,0;0,0,0,0)$.*

That is, there exist exactly two equilibrium outcomes that are fully revealing; these differ from each other only with respect to the labeling of the candidates. In each one of the equilibrium outcomes, one of the candidates is winning the election with probability one regardless of which policy platforms he and the other candidate have chosen. The winning candidate is choosing policy B if observing a signal B, and policy N if observing a signal N. The candidate who is always losing chooses policy N if observing a signal B, and policy B if observing a signal N. In other words, equilibria where the voter can infer both candidates' information do exist, but having this information is not very useful for the voter; she always votes for one of the candidates anyway, mainly because the losing candidate's behavior is rather odd: he always does the opposite to what his signal suggests he "should" do.

[14] Formally, when we say that the candidates "choose pure strategies" (or "play pure") in an equilibrium, we mean that, in this equilibrium, $\sigma_1^B, \sigma_1^N, \sigma_2^B, \sigma_2^N \in \{0,1\}$.

Why is it impossible to have an equilibrium in which both candidates announce platforms identical to their signals? The basic reason is that the policy that the voter prefers when only knowing the prior (i.e., policy B) has a too strong drawing power. To see this, suppose that we indeed had an equilibrium in which both candidates simply announced their signals. Now, if it turns out that the candidates have chosen different platforms, then the voter can infer that one of them has received a signal in favor of B while the other one has received a signal in favor of N. Since the quality of the signals are the same, the informational value of the two signals will cancel out and B is still the alternative that is most likely to be the best one. Hence, the voter will elect the candidate choosing platform B. Anticipating this, a candidate who has received a signal N will have an incentive, we claim, not to choose platform N but platform B.

To see why this claim is true, suppose for simplicity that when both candidates have chosen the same platform, the voter elects either one with equal probability.[15] Then, if a candidate who has received a signal in favor of policy N follows his equilibrium strategy and chooses platform N, then he will lose for sure if his opponent has received a signal B and win with probability .5 if his opponent also has received a signal N. On the other hand, if he deviates and chooses policy B, he will win with probability .5 if the opponent also has received a signal B and win for sure if the opponent has received a signal N. Thus, there is a profitable deviation for a candidate who has received a signal N, and therefore the prescribed behavior cannot be part of an equilibrium.

Let us now calculate the voter's expected utility in a fully revealing equilibrium described in Proposition 1, which we denote by EU_{FR}. We know that in this kind of equilibrium one of the candidates always wins the election, and this candidate chooses platform B if and only if he has observed a signal B. We therefore get

$$\begin{aligned} EU_{FR} &= \Pr(\omega = \omega_B)\Pr(s_1 = B \mid \omega = \omega_B) + \\ &\quad \Pr(\omega = \omega_N)\Pr(s_1 = N \mid \omega = \omega_N) \\ &= q(1-\varepsilon) + (1-q)(1-\varepsilon) = 1-\varepsilon. \end{aligned} \tag{5}$$

[15] Of course, since the voter is indifferent between the candidates when they have chosen the same platform, there is no particular reason why the voter would not randomize with some other probability. A proof of Proposition 1 must, therefore, generalize the argument in the text to any probability. We do this in the Appendix.

The graph of EU_{FR} is depicted in Figure 1. Unsurprisingly, EU_{FR} is strictly lower than the expected utility in the welfare benchmark, EU_{BM}.

Let us now consider existence of babbling equilibria. Remember that our model — similarly to standard cheap talk games — has the feature that choosing policy platforms has no cost to the candidates other than that inherent in the voter's choice whom to vote for. This means that babbling equilibria always exist. For if the voter does not believe that the candidates' platform choices contain any information, then the candidates have no incentive to make their choices contingent on their signals, which in turn confirms the voter's beliefs. Proposition 2 below characterizes all babbling equilibria in which the candidates play pure.

Proposition 2 (Babbling). *Babbling equilibria exist. A strategy profile σ is part of a babbling equilibrium in which the candidates play pure strategies if and only if:*[16]

(a) $\sigma = \left(1,1;1,1;\sigma_3^{BB},\sigma_3^{BN},\sigma_3^{NB},\sigma_3^{NN}\right)$ *and* $\sigma_3^{NB} \leq \sigma_3^{BB} \leq \sigma_3^{BN}$ *and, for* $q \in (1-\varepsilon,\widetilde{q})$, $\left(\sigma_3^{BN},\sigma_3^{NB}\right) = (1,0)$*; or*

(b) $\sigma = \left(1,1;0,0;1,1,\sigma_3^{NB},\sigma_3^{NN}\right)$ *; or*

(c) $\sigma = \left(0,0;1,1;0,\sigma_3^{BN},0,\sigma_3^{NN}\right)$*; or*

(d) $q \in \left(\frac{1}{2},1-\varepsilon\right]$ *and* $\sigma = \left(0,0;0,0;\sigma_3^{BB},\sigma_3^{BN},\sigma_3^{NB},\sigma_3^{NN}\right)$ *and* $\sigma_3^{BN} \leq \sigma_3^{NN} \leq \sigma_3^{NB}$.

In the kind of babbling equilibria described in part (a), (b), and (c) of Proposition 2, policy B will always be implemented. In part (a), both candidates may win with positive probability and, when choosing their platforms, they both follow the voter's prior — that is, they pick policy B with probability one. In part (b) and (c), one of the candidates is losing the election with probability one; therefore, this candidate is indifferent between the policies B and N and thus has a (weak) incentive to choose policy N.

In the kind of babbling equilibria described in part (d) of Proposition 2, policy N will always be implemented. This equilibrium outcome is indeed rather odd. It can be sustained only because the voter's out-of-equilibrium beliefs are

[16] In order to make the statement of the proposition as brief as possible, we use the convention that, unless specified otherwise, each σ_3^{jk} can take any value in the unit interval.

such that if a candidate is the only one choosing platform B, then the voter believes that this candidate observed a signal in favor of N with a sufficiently high probability.[17] Intuitively, the voter distrusts a candidate who chooses policy B. It is not only that she thinks that this candidate is a populist who follows popular beliefs; she also thinks the candidate is (sufficiently much) more likely to follow the prior whenever he has information indicating that the prior is incorrect. If the voter's prior is low enough (i.e., if $q \leq 1 - \varepsilon$), this "distrust" induces her to effectively punish a deviating candidate.

Consider the voter's expected welfare in the equilibria described in part (a), (b), and (c) of Proposition 2. Since here the winning candidate always chooses platform B, the voter's expected utility, denoted EU_{bab}^{B}, is simply given by the prior: $EU_{bab}^{B} = \Pr(\omega = \omega_B) = q$. The graph of this function is depicted in Figure 1. Similarly, the voter's expected utility in a babbling equilibrium in which the winning candidate chooses N (i.e., part (d) of Proposition 2), denoted EU_{bab}^{N}, is given by $EU_{bab}^{N} = \Pr(\omega = \omega_N) = 1 - q$ (see again Figure 1). Both the babbling equilibrium outcomes are in welfare terms worse than the outcome of the welfare benchmark. This is, of course, particularly true for the equilibrium where the candidates babble on N. Furthermore, it follows from Figure 1 that, for $q > 1 - \varepsilon$, the fully revealing equilibrium is worse in welfare terms than the equilibrium in which both candidates babble on B.

Some of the equilibria that are characterized in Propositions 1 and 2 seem to be quite fragile. For example, the reason why we can sustain a fully revealing equilibrium in which one candidate always "does the opposite" is that this candidate is always losing the election. That is, even in the case where both candidates have chosen the same platform, so that the voter is indifferent between them, the voter elects one of the candidates with probability one. Similarly, the reason why we can sustain a babbling equilibrium in which one candidate always chooses B and the other always chooses N (i.e., the equilibria in part (b) and (c) of Proposition 2) is that, if the latter candidate deviated to the B platform, the voter would vote for the former candidate with probability one.

[17] Indeed, equilibria that are "truly" babbling — in the sense that both the voter's equilibrium and out-of-equilibrium beliefs are identical to her prior beliefs — can be found only in part (a), (b), and (c).

It is questionable whether an equilibrium outcome where the voter behaves in this fashion is a reasonable prediction of the game. One can, for example, wonder what a candidate who knows that he will lose with probability one is doing in the race in the first place. We now introduce a tie-breaking rule that rules out this kind of behavior on the part of the voter.

Assumption 1 (Tie-Breaking Rule). *Whenever the voter is indifferent between the candidates, the voter elects each candidate with a given positive probability. That is,* $\sigma_3^{BB} = \sigma_3^{NN} = \alpha \in (0,1)$. *Moreover, if the voter is indifferent after having observed* $(x_1, x_2) = (B, N)$ *(respectively,* $(x_1, x_2) = (N, B)$*), then* $\sigma_3^{BN} = \alpha$ *(respectively,* $\sigma_3^{NB} = \alpha$*).*

This kind of tie-breaking rule is common in the literature on electoral competition.[18] Moreover, we believe that it can be justified as capturing, in a simple way, what one would get as an equilibrium outcome of a more elaborate model with uncertainty on the part of the candidates about the voter's preferences.[19]

As can be seen from Proposition 1, Assumption 1 rules out the possibility of an equilibrium with full revelation. Furthermore, it rules out part (b) and (c) of Proposition 2. We have not yet, however, considered the possible existence of equilibria in which the candidates play pure other than those covered by Propositions 1 and 2. Before we conclude this subsection we will, therefore, in the

[18] For instance, in standard formulations of the Hotelling-Downs model, if the two candidates choose the same platform, it is assumed that they share the votes equally; see, e.g., Osborne (1995).

[19] In particular, what we have in mind here is a story in which members of the electorate have preferences also over some personal characteristic of the candidates such as their leadership ability or their looks (the latter terminology is used by Rogoff 1990). This concern on the part of a voter enters additively in her payoff function. Moreover, the sign and the exact magnitude of this additive term, which we denote η, is unknown to the candidates. To make our story more concrete, suppose, to start with, that the support of η is $[-\eta^*, \eta^*]$ where η^* is very large. Then the voting behavior for a given a platform configuration will not be perfectly predictable for the candidates, and no candidate ever expects to lose with probability one. Furthermore, since the "looks" term η enters additively in the payoff function, the candidates' winning probabilities should be positive constants and the same whenever the voter is indifferent between the platforms — as our tie-breaking rule requires. For electoral competition models where this kind of approach (i.e., so-called probabilistic voting) is used, see for example Coughlin (1992).

The above assumption about the support of η would not give us Assumption 1 exactly. The reason for this is that Assumption 1 allows a candidate to win with probability one if the platforms differ and if the voter's beliefs are such that she prefers one platform to the other. If we instead assumed that the η term has support $\{-\eta^*, \eta^*\}$ and that η^* is very small, however, then, as $\eta^* \to 0$, one should get the tie-breaking rule that we impose.

We believe that, in our model, explicitly following one of the above approaches would make for a more complex analysis without qualitatively changing our results or providing new insights, and we have therefore decided not to do this. Instead we use the shortcut of simply imposing Assumption 1.

following paragraph show that any such equilibrium cannot survive Assumption 1.

In order to characterize all equilibria that satisfy Assumption 1 and in which the candidates play pure strategies we are left to consider the possibility of equilibria in which one candidate babbles and the other fully reveals his signal. Suppose such an equilibrium exists. Along the equilibrium path of any such equilibrium, the voter will face two situations: one in which the candidates announced the same platform and another in which they announced different platforms. Since the voter learns exactly one signal in the kind of equilibrium under consideration, she strictly prefers one of the candidates to the other whenever their platforms differ (we ignore the knife-edge case in which $q = 1 - \varepsilon$). Hence, whenever $x_1 \neq x_2$, she either votes for (i) the fully revealing candidate or (ii) the babbling candidate with probability one. In case (i), however, the revealing candidate has a strict incentive to always announce the platform that the babbling candidate has not chosen; this is because if he chose the same platform as the babbling candidate, then, by Assumption 1, he would get elected with a probability strictly less than one. Similarly, in case (ii), the revealing candidate always has an incentive to choose the same platform as the babbling candidate; this is because here he gets elected with positive probability if and only if his platform is identical to the babbling candidate's platform. We conclude that partially revealing equilibria that satisfy Assumption 1 and in which the candidates play pure strategies do not exist.

Hence, when we impose Assumption 1, the only remaining equilibria are the babbling equilibria in part (a) and part (d) of Proposition 2. We state this result in the following proposition.

Proposition 3 (Surviving Pure Equilibria). *Let $q \neq 1 - \varepsilon$. Then the only equilibria that survive Assumption 1 and in which the candidates play pure strategies belong to the class of babbling equilibria described in either part (a) of Proposition 2 ("the popular-beliefs equilibria") or part (d) of Proposition 2 ("the bad babbling equilibria").*

We can conclude that, within the family of equilibria in which the candidates play pure and for $q < 1 - \varepsilon$,[20] there are two possible equilibrium outcomes that

[20] Recall from Proposition 2 that the bad babbling equilibria do not exist for $q > 1 - \varepsilon$.

survive the tie-breaking rule: one in which both candidates choose platform B with probability one and another in which they both choose platform N with probability one. Hence, for low enough values of the prior, imposing Assumption 1 does not yield a unique equilibrium outcome. One natural criterion for selecting among the remaining equilibria, which is often used in applications of cheap talk games, is to assume that an equilibrium is not played if its associated outcome is Pareto dominated by some other equilibrium outcome. If we use this criterion, then, for all q (such that $q \neq 1-\varepsilon$), the outcome of the popular-beliefs equilibria is the only one that survives. This result follows immediately from the fact that the candidates (by Assumption 1) are equally well off under the popular-beliefs equilibrium outcome as under the bad babbling equilibrium outcome, and the voter strictly prefers the popular-beliefs outcome. Invoking this result, we claim that, provided the candidates are required to play pure, the most reasonable prediction of the game is the popular-beliefs equilibrium.

4.2 Candidates' Mixing

Our focus so far in the paper on equilibria where both candidates play pure strategies has strong support if one looks at the common practice in the literature. The possibility that the candidates may randomize in their platform choices is, in a large part of the literature on electoral competition, ruled out by assumption. One argument in favor of this (here formulated by Ordeshook 1986, p. 181) is that "(...) it seems silly to conceptualize candidates spinning spinners or rolling dice to choose policy platforms." One need not, however, interpret these mixed equilibria literally as the candidates' introducing randomness in their behavior.[21] Moreover, in our model there is a special reason why the focus on equilibria where the candidates play pure may be overly restrictive: if we allowed the candidates to randomize, it is conceivable that they would be able to transmit more information than otherwise, since then (and only then) they would be able to choose the amount of noise in their messages continuously and endogenously. The result that communication in cheap talk games has a coarse nature and that the coarseness is endogenously determined as a function of the degree to which there is a conflict of interest between the communicating

[21] See Osborne and Rubinstein (1994, pp. 37-44) for a discussion of interpretations of mixed strategy equilibria.

parties is well known since the work of Crawford and Sobel (1982).[22]

It thus seems motivated to consider also the existence and the welfare properties of equilibria in which at least one of the candidates is mixing at at least one of his information sets. By doing so, we will be able to check the robustness of our "follow-popular-beliefs" result from the previous subsection, and we should in addition be able to do some interesting comparative-statics exercises which were not possible in the pure-strategy analysis. Throughout the rest of the paper we maintain Assumption 1. In Proposition 4 below we characterize all partially revealing equilibria that, in addition, meet the following condition (we will later consider also those equilibria that do **not** satisfy the condition).

Condition 1 (Voter Indifference). *The candidates' behavior is such that:*

(a) $(x_1, x_2) = (B, N)$ *and* $(x_1, x_2) = (N, B)$ *are played along the equilibrium path. That is: (i) we do not have* $\sigma_i^B = \sigma_i^N = 0$ *nor* $\sigma_i^B = \sigma_i^N = 1$ *(for i=1,2).*

(b) *The voter's updated beliefs after having observed one platform B and one platform N put equal weights on the state being B and the state being N. That is,*

$$\Pr(\omega = \omega_B \mid x_1 = B, x_2 = N) = \Pr(\omega = \omega_B \mid x_1 = N, x_2 = B) = \frac{1}{2}.$$

Notice that any equilibrium that satisfies Condition 1 must be partially revealing: if it was either babbling or fully revealing, part (b) of the condition would not hold.

To state Proposition 4 it is helpful to define

$$\Omega \equiv \left\{ \sigma \in [0,1]^8 \mid \text{Assumption 1 and Condition 1 hold} \right\}.$$

Trivially, if there is an equilibrium where $\sigma \in \Omega$, then this equilibrium satisfies Assumption 1 and Condition 1; Proposition 4 establishes that also the reverse implication holds.

[22] In a recent paper, however, Battaglini (2000) has challenged this view. He shows that in a cheap talk game which has a two-dimensional policy and state space and in which there are two senders (both perfectly informed about the true state), there always exists a fully revealing equilibrium provided that a weak condition is satisfied. Moreover, whether this condition is met does not depend on the proximity of the players' ideal points but the local behavior of the senders' indifference curves at the ideal point of the receiver.

Proposition 4 (Partial Revelation with Condition 1). *Equilibria that satisfy Assumption 1 and Condition 1 exist if and only if $\sigma \in \Omega$. Moreover, the set Ω is non-empty if and only if $q < 1 - \varepsilon$.*

In the Appendix (see Lemma A4) we prove that, provided Assumption 1 is satisfied, Condition 1 implies equations (6) and (7), which are stated below. Furthermore, if Condition 1a is met, then equations (6) and (7) imply Condition 1b. Intuitively, for the cases in which Bayes' rule defines the voter's beliefs at any information set (i.e., Condition 1a is met), equations (6) and (7) ensure that the voter's beliefs are such that he is indifferent between the candidates (i.e., that Condition 1b holds).

$$\begin{aligned}&\sigma_1^B\left(1-\sigma_2^B\right)(q-\varepsilon)+\left(\sigma_1^B-\sigma_1^N\right)\left(\sigma_2^B-\sigma_2^N\right)\varepsilon(1-\varepsilon)(2q-1)\\&=\sigma_1^N\left(1-\sigma_2^N\right)(1-\varepsilon-q),\end{aligned} \tag{6}$$

$$\left(\sigma_1^B-\sigma_2^B\right)(q-\varepsilon)=\left(\sigma_1^N-\sigma_2^N\right)(1-\varepsilon-q). \tag{7}$$

In order to get a better feeling for how these equilibria may look like, let us first impose symmetry; i.e., $\sigma_1^B = \sigma_2^B = \sigma^B$ and $\sigma_1^N = \sigma_2^N = \sigma^N$. The two equalities (6) and (7) then simplify to the following single equation:

$$\begin{aligned}&\sigma^B\left(1-\sigma^B\right)(q-\varepsilon)+\left(\sigma^B-\sigma^N\right)^2\varepsilon(1-\varepsilon)(2q-1)\\&=\sigma^N\left(1-\sigma^N\right)(1-\varepsilon-q).\end{aligned} \tag{8}$$

Let us first note that equation (8) implies that there is no partially revealing equilibrium in which $\sigma^N = 0$ or $\sigma^N = 1$. For $\sigma^B = 0$ or $\sigma^B = 1$, however, we get two neat examples of partially revealing equilibria in which the candidates randomize in their platform choice when observing a signal N. Our following discussion focuses on the equilibrium in which $\sigma^B = 1$, since we will argue below that, for $q < 1 - \varepsilon$, this is the most reasonable prediction of the game. Nevertheless, we also provide a short discussion of the case in which $\sigma^B = 0$, because this gives additional insights into the class of equilibria under consideration.

Setting $\sigma^B = 1$ in (8) and then solving for σ^N, one has

$$\sigma^N=\frac{\varepsilon(1-\varepsilon)(2q-1)}{(1-\varepsilon)^2(1-q)-\varepsilon^2 q}\equiv f(q,\varepsilon). \tag{9}$$

In other words, there is an equilibrium in which both candidates choose platform B with probability one when they have observed a signal in favor of B, and they choose platform B with probability $f(q,\varepsilon)$ when they have observed a signal in favor of N. In this equilibrium, if the voter observes the platform configuration $(x_1, x_2) = (B, N)$, for example, she can infer that candidate 2 observed a signal in favor of N. Candidate 1, however, may or may not have observed a signal in favor of B; this is because, with a probability $f(q,\varepsilon)$ (> 0), candidate 1 chooses platform B after having observed a signal in favor of N.

Taking this endogenous noise into account, the voter calculates the probability that candidate 1 indeed observed a signal in favor of B. She then uses this probability and the fact that candidate 2 has observed a signal in favor of N to update her beliefs about the true state. The magnitude of the endogenous noise $f(q,\varepsilon)$ is such that, after this updating, the two states are equally likely. Hence, the voter is indifferent between the candidates and, by Assumption 1, votes for candidate 1 with probability $\alpha \in (0,1)$. Since the candidates' strategies are symmetric in this equilibrium, the voter is also indifferent between the candidates when she observes the platform configuration $(x_1, x_2) = (N, B)$. This means that the candidates win the election with the same probability for all platform configurations. Thus, it is indeed (weakly) optimal for them to randomize between the platforms when they have observed a signal in favor of N, which in turn confirms that $f(q,\varepsilon)$ can be part of an equilibrium.

One can check that the function $f(q,\varepsilon)$ is indeed a well-defined probability since it takes values strictly between zero and one for all $q \in (1/2, 1-\varepsilon)$ and all $\varepsilon \in (0, 1-q)$. One can also verify that $f(q,\varepsilon)$ is increasing in q, with $f(1/2,\varepsilon) = 0$ and $f(1-\varepsilon,\varepsilon) = 1$. This means that, as q approaches 1/2, the endogenous noise vanishes and we approach full revelation (cf. Observation 2 in Section 3). As q increases, however, so that the voter's prior beliefs get more biased in favor of policy B, the endogenous noise gets monotonically larger; in the limit, as q approaches $1-\varepsilon$, the equilibrium approaches the popular beliefs-equilibrium discussed in the previous subsection (i.e., the equilibrium where both candidates babble on B).

Furthermore, $f(q,\varepsilon)$ is increasing also in its second argument, ε, with $f(q,0) = 0$ and $f(q,1-q) = 1$. That is, as the probability that a candidate gets an incorrect signal increases (which also means that the two candidates' signals become less correlated), the endogenous noise gets monotonically larger. In particular, as ε varies, one moves continuously from an equilibrium that is close to the popular-beliefs equilibrium (as $\varepsilon \to 1-q$) to an equilibrium with close to full revelation (as $\varepsilon \to 0$) (cf. Observation 1 in Section 3). This means that, in the equilibrium under consideration, a decrease in ε has an unambiguously positive effect on the voter's expected utility: a lower ε means that (i) there is more information available to the candidates, and (ii) the amount of endogenous noise gets smaller.[23]

For an increase in the prior q, however, the corresponding two effects will go in different directions: a larger q means that (i) there is more information available to the candidates and to the voter, and (ii) the amount of endogenous noise gets larger. To see which of these two effects dominates, we calculate the voter's expected utility in this equilibrium, denoted EU_{PR}^{f}:[24]

$$EU_{PR}^{f} = 1 - \varepsilon - f(q, \varepsilon)(1 - \varepsilon - q). \tag{10}$$

The graph of EU_{PR}^{f} is depicted in Figure 2 as a function of q.[25] This graph tells us that for low enough values of q, the negative effect of a larger amount of endogenous noise has a heavier weight than the direct and positive effect of having more information around ex ante. The level of q that yields the lowest expected utility is given by

$$q^{\circ}(\varepsilon) = \sqrt{\frac{(1-\varepsilon)(2-3\varepsilon)}{2[1-2\varepsilon(1-\varepsilon)]}}. \tag{11}$$

One can show that the function q° is strictly decreasing with $q^{\circ}(0) = 1$ and $q^{\circ}(1/2) = 1/2$. This means that the threshold value $q^{\circ}(\varepsilon)$ is close to unity for low values of ε. In other words, if the candidates' signals are very accurate then the voter's expected utility is, for almost all q's, decreasing in her prior. When

[23] In general, as we saw in the analysis of the previous subsection, an increase in information transmission does not necessarily increase the voter's welfare. In the equilibrium under consideration, however, more information is transmitted because the candidates (i) receive the correct signal more often and (ii) choose the platform identical (rather than opposed) to their signal more often. Hence, the two effects reinforce themselves to increase the voter's expected welfare.

[24] Equation (10) is implied by Lemma A6, which is stated and proven in the Appendix.

[25] In Claim 1 in the Appendix we prove that EU_{PR}^{f} indeed has the shape indicated by the figure. That is, EU_{PR}^{f} is convex in q. Furthermore, one can show that $\lim_{q\to 1/2} EU_{PR}^{f} = \lim_{q\to 1-\varepsilon} EU_{PR}^{f} = 1-\varepsilon$.

the error term ε gets close to $1/2$, however, so that the candidates' signals are almost uninformative, the voter is better off from an increase in the prior q for almost all values of this parameter. Loosely speaking, in this equilibrium, more (prior) information hurts the voter if politicians are very competent. It benefits the voter, however, if the politicians are not much better informed than the voter herself. The intuition for this result is that when politicians are very competent they are likely to learn the true state through their signal; hence it does not matter much what the value of q is, and the positive effect of more prior information is therefore insignificant.

As mentioned above, from equation (8) we can get a second neat example of an equilibrium in which the candidates randomize in their platform choice when observing a signal N. This equilibrium is obtained by setting $\sigma^B = 0$ in (8) and then solving for σ^N. Doing this, we get $\sigma^N = 1 - f(q, \varepsilon)$. That is, in this equilibrium the candidates' behavior is in a certain sense opposite to the behavior in the previously discussed mixed equilibrium: when they observe a signal in favor of B, they choose policy N with probability 1; and when they observe an N signal, they choose policy B with probability $1 - f(q, \varepsilon)$. Thus, again f can be thought of as a measure of the endogenous noise. In particular, when the noise is small, we are close to a full revelation equilibrium in which both candidates do the opposite of what they "should": they choose platform N after having observed a signal in favor of B, and platform B upon having observed a signal in favor of N. When the noise is very large, we are close to a babbling equilibrium in which both candidates always choose N. Obviously, this equilibrium is very bad for the voter in welfare terms. Her expected utility in this equilibrium, denoted EU_{PR}^{1-f}, can be written

$$EU_{PR}^{1-f} = \varepsilon + f(q, \varepsilon)(1 - \varepsilon - q), \tag{12}$$

which has its maximum at the same value of q for which EU_{PR}^{f} has its minimum, namely $q^\circ(\varepsilon)$.

Besides the two equilibria that are associated with the function f and which are discussed above, there exist other equilibria that are implicitly defined by equations (6) and (7). It turns out, however, that the equilibrium that is best from the voter's point of view among the equilibria in this family is the first mixed equilibrium discussed above (which we therefore, from now on, will refer to as **the good mixed equilibrium**). This is stated in the following proposition.

Proposition 5 (The Good Mixed Equilibrium). *Suppose that $q < 1 - \varepsilon$. Then there exists an equilibrium in which $\sigma = (1, f(q, \varepsilon); 1, f(q, \varepsilon); \alpha, \alpha, \alpha, \alpha)$. The outcome of this equilibrium Pareto dominates the outcomes of all other equilibria that satisfy Assumption 1 and Condition 1.*

Recall that the expected utility for a candidate is the same in all equilibria that satisfy Condition 1. Hence, the second part of Proposition 5 amounts to saying that the voter is strictly better off in the good mixed equilibrium than in any other equilibrium that satisfies Condition 1. What is the intuition for this? We know that the best thing for the voter would be if both candidates, with probability one, followed their signals when choosing platforms (cf. the planner's problem in the welfare benchmark in Section 3). This behavior, however, would not be consistent with the incentive constraints: a candidate cannot follow his signal with probability one **both** when he has observed a **B** and an **N** signal. Given this tradeoff, the best thing for the voter is if the candidates truthfully follow their B signals rather than their N signals; the reason for this is basically that (unconditionally on the true state) a B signal is (i) more likely to be observed and (ii) more likely to be correct.

So far we have considered equilibria satisfying Condition 1 (and Assumption 1). In the following proposition we characterize the welfare properties of all equilibria that do **not** satisfy Condition 1.

Proposition 6 (Partial Revelation without Condition 1). *Suppose Assumption 1 is satisfied. Then, in any equilibrium in which Condition 1 is not satisfied, candidate 1 gets elected with probability α and the voter's expected welfare is equal to her expected welfare in either the popular-beliefs equilibria or the bad babbling equilibria.*

We establish this proposition by simply considering all possible candidates' strategies that do not satisfy Condition 1. In an analytically tedious, but conceptually straightforward fashion, we show (see the Appendix) that such strategies are either not part of an equilibrium or give rise to welfare of one of the babbling equilibria. In proving the above proposition, we use the fact that any partially revealing equilibrium that satisfies Assumption 1 but not Condition 1 has two features. First, one of the candidates babbles.[26] Second, along the equilibrium path, the voter is always indifferent between the candidates.[27] These features imply that the voter's expected welfare is equal to her expected welfare of either the popular-beliefs equilibria or the bad babbling equilibria. Furthermore, the second feature together with Assumption 1 imply that candidate 1 gets elected with probability α.

We are now ready to state our final proposition, which gives us a unique prediction of the model.

Proposition 7 (Unique Prediction). *Suppose Assumption 1 is satisfied. Then, for $q < 1 - \varepsilon$, the outcome of the good mixed equilibrium Pareto dominates all other equilibrium outcomes. For $q > 1 - \varepsilon$, the unique equilibrium outcome is the popular-beliefs equilibrium outcome.*

Proof: First, consider the case in which Assumption 1 is satisfied and $q < 1 - \varepsilon$. Given Propositions 5 and 6, we are left to show that, in this case, $EU^f_{PR} > EU^B_{bab}$. This inequality can equivalently be written

$$1 - \varepsilon - f(q, \varepsilon)(1 - \varepsilon - q) > q. \tag{13}$$

Inequality (13), in turn, is equivalent to $1 > f(q, \varepsilon)$, which always hold for $q < 1 - \varepsilon$. Next, consider the remaining case in which Assumption 1 is satisfied and $q > 1 - \varepsilon$. Proposition 4 rules out the existence of any equilibria satisfying Condition 1 in this case. Furthermore, it follows from Proposition 6 and the proof thereof that, in any equilibrium satisfying Assumption 1 but violating Condition 1, at least one of the candidates babbles. Therefore, the voter can infer information about at most one candidate's signal in such an equilibrium. Thus, for $q > 1 - \varepsilon$ she always prefers policy B in equilibrium. Therefore, she would never elect a candidate who announces policy N in such an equilibrium.

[26] To establish feature one, suppose to the contrary that none of the candidates babble. Then Condition 1a is met. We show in the appendix, however, that in this case the candidates' incentive constraints require that along the equilibrium path the probability of a candidate getting elected must be independent of his announcement. Thus, Condition 1b is also met if none of the candidates babbles, which establishes feature one.

[27] By feature one, one candidate, say candidate 1, babbles. By Assumption 1, candidate 2 is elected with probability $1 - \alpha$ if he matches the babbling candidate's platform. For candidate 2 to have an incentive to play both platforms, he must be elected with the same probability if he does not match the babbling player's plattform. Thus, the voter must be indifferent between the candidates along the equilibrium path.

Hence, both candidates have a strict incentive to announce policy B and thus, for $q > 1-\varepsilon$, the only equilibria that satisfy Assumption 1 are the popular-beliefs equilibria. Q.E.D.

Proposition 7 states that if more than one candidate's signal is needed to persuade the voter that policy N is the best policy (i.e., if $q > 1 - \varepsilon$) then the only equilibrium surviving the tie-breaking rule is the popular-beliefs equilibrium. In other words, if the voter is dependent on the aggregate information of the candidates rather than simply the information of one individual candidate, then any credible information revelation is infeasible. For lower values of the voter's prior (i.e., for $q < 1 - \varepsilon$), some information can credibly be transmitted from the candidates to the voter. There is, however, always a tendency for the candidates to follow popular beliefs rather than their own information. As our earlier comparative statics exercises showed, this tendency becomes stronger, the more dispersed is information between the candidates and the stronger are the popular beliefs. We also saw that, since stronger popular beliefs make information transmission more difficult, more prior information will for any q low enough (namely, for $q < q^{\circ}(\varepsilon)$) have a detrimental effect on the voter's expected welfare.

5 Summary and Discussion

In this paper we have addressed the question whether information that is dispersed between two political candidates can be credibly transmitted to voters. We imposed two equilibrium refinements in our analysis. The first refinement requires the voter to elect each candidate with a given positive probability if she is indifferent between them. The second refinement rules out equilibria with outcomes that are Pareto dominated by another equilibrium outcome. These refinements gave us the following unique prediction: if information is sufficiently much dispersed between the candidates then the candidates, with probability one, choose the policy favored by the voter's prior; that is, no information is transmitted to the voter. If the candidates information is sufficiently much correlated, then a mixed equilibrium is played in which the candidates' behavior is distorted toward the policy favored by the voter's prior; that is, some but not all of the candidates' information is revealed. Furthermore, in this mixed equilibrium, information transmission becomes more difficult, the more the information is dispersed between the candidates and the stronger is the electorate's prior. Indeed, as more prior information becomes available, welfare can *decrease*.

Important for our results is the assumption that the candidates can only make their platform choices contingent on their own information and not on what their competitor says. That is, we do not allow platforms that take the form "I promise to lower taxes if I *and my competitor* say that this is good for the economy." It seems natural to rule out such commitments in a model of electoral competition, partly because we do not observe them in reality. If we allowed the candidates to make such commitments, however, then they would be able to transmit all their information to the electorate. Thus, an interesting research question is why we do not observe this kind of commitments. One possible explanation is that if a candidate's competence is unknown, then a candidate who makes his own policy choice dependent on his competitor's opinion may signal that he does not trust his own judgement — i.e., that the candidate believes he is of low competence.

Another reason why our particular commitment assumption is important is that if the candidates were not able to commit to *any* policy platform, then they may — once they are in office — simply do what is in the voter's interest. This may at least partially mitigate the information transmission problem. In this paper our approach has been to take the commitment as given and to investigate the consequences of such a commitment. Hence, as in most models of electoral competition, commitment takes place for exogenous reasons. Nevertheless, our results give insights into the cost of commitment, namely the reduction of information transmission from candidates to voters. Therefore, our results could be helpful in understanding when and why candidates commit to policies.

The results of our model do not only raise additional doubts about Wittman's argument that a political entrepreneur will be able to provide voters with the relevant information, but also give insights into the nature of electoral competition that should prove useful in addressing other issues. First, the result that candidates have an incentive to follow popular opinion suggests that a candidate who wants to win an election should use his campaign funds to buy public opinion polls rather than hiring an expert on the policy issue itself. Second, our result that candidates will have difficulties in credibly transmitting their information to the electorate may explain why lobbying groups sometimes address the electorate directly (e.g. through costly TV commercials) rather than providing the candidates with the same information. Similarly, our results also have implications for members of the economics profession who are interested in influencing public policy. For example, the importance of popular beliefs in our model may give insights into why famous economists, such as Paul Krugman, write newspaper articles to address the public.

6 Appendix

In this Appendix we prove the propositions stated in Section 4. We first need to introduce some more notation. Let $P_{B|B}$ be defined by

$$P_{B|B} \equiv \Pr(s_2 = B \mid s_1 = B) \equiv \Pr(s_1 = B \mid s_2 = B). \tag{14}$$

(The latter identity holds because the quality of the two signals are the same.) Similarly, we define

$$P_{N|N} \equiv \Pr(s_2 = N \mid s_1 = N) \equiv \Pr(s_1 = N \mid s_2 = N), \tag{15}$$

$$P_{B|N} \equiv \Pr(s_2 = B \mid s_1 = N) \equiv \Pr(s_1 = B \mid s_2 = N) \equiv 1 - P_{N|N}, \tag{16}$$

and

$$P_{N|B} \equiv \Pr(s_2 = N \mid s_1 = B) \equiv \Pr(s_1 = N \mid s_2 = B) \equiv 1 - P_{B|B}. \tag{17}$$

Proof of Proposition 1 For an equilibrium to be fully revealing we must have $\sigma_i^B \in \{0,1\}$ and $\sigma_i^N = 1 - \sigma_i^B$. Thus, there are four cases to consider: (i) $\sigma_1^B = \sigma_2^B = 1$ and $\sigma_1^N = \sigma_2^N = 0$; (ii) $\sigma_1^B = \sigma_2^B = 0$ and $\sigma_1^N = \sigma_2^N = 1$; (iii) $\sigma_1^B = \sigma_2^N = 1$ and $\sigma_1^N = \sigma_2^B = 0$; and (iv) $\sigma_1^N = \sigma_2^B = 1$ and $\sigma_1^B = \sigma_2^N = 0$. We must show that: (i) and (ii) cannot be part of an equilibrium; (iii) is part of an equilibrium iff $\sigma_3^{BB} = \sigma_3^{BN} = \sigma_3^{NB} = \sigma_3^{NN} = 1$; and (iv) is part of an equilibrium iff $\sigma_3^{BB} = \sigma_3^{BN} = \sigma_3^{NB} = \sigma_3^{NN} = 0$.

Suppose (i) is part of an equilibrium. By definition, in any fully revealing equilibrium the voter can infer both candidates' signals. Because in (i) a candidate's chosen policy platform is always identical to the signal he has received, the candidate who has chosen platform B wins whenever the chosen platforms differ: $\sigma_3^{BN} = 1$ and $\sigma_3^{NB} = 0$. In equilibrium, choosing policy N when having observed a signal N (i.e., $\sigma_i^N = 0$) must be a best response for both candidates; i.e.:

$$\sigma_3^{NN} P_{N|N} \geq \sigma_3^{BB} P_{B|N} + P_{N|N}, \tag{18}$$

$$\left(1 - \sigma_3^{NN}\right) P_{N|N} \geq \left(1 - \sigma_3^{BB}\right) P_{B|N} + P_{N|N}. \tag{19}$$

Adding inequalities (18) and (19) yields $P_{N|N} \geq P_{B|N} + 2P_{N|N}$, which is impossible (recall that $P_{B|N} = 1 - P_{N|N}$).

Now, suppose (ii) is part of an equilibrium. Again, the voter can infer both candidates' signals. Because in (ii) a candidate's chosen policy platform is always opposite to the signal he has received, the candidate who has chosen platform B, again, wins whenever the chosen platforms differ: $\sigma_3^{BN} = 1$ and $\sigma_3^{NB} = 0$. In equilibrium, choosing policy N when having observed a signal B (i.e., $\sigma_i^B = 0$) must be a best response for both candidates; i.e.:

$$\sigma_3^{NN} P_{B|B} \geq \sigma_3^{BB} P_{N|B} + P_{B|B}, \tag{20}$$

$$\left(1 - \sigma_3^{NN}\right) P_{B|B} \geq \left(1 - \sigma_3^{BB}\right) P_{N|B} + P_{B|B}. \tag{21}$$

Adding inequalities (20) and (21) yields $P_{B|B} \geq P_{N|B} + 2P_{B|B}$, which is impossible (recall that $P_{N|B} = 1 - P_{B|B}$).

Next, consider case (iii). Again, the candidate can infer both candidates' signals. Because candidate 1's chosen signal is always identical to the signal he has received and candidate 2's chosen signal is always opposite to the signal he has received, candidate 1 wins whenever the chosen platforms differ: $\sigma_3^{BN} = 1$ and $\sigma_3^{NB} = 1$. In equilibrium, candidate 2 choosing policy N when having observed a signal B (i.e., $\sigma_2^B = 0$) must be a best response:

$$\left(1 - \sigma_3^{NN}\right) P_{N|B} \geq \left(1 - \sigma_3^{BB}\right) P_{B|B}. \tag{22}$$

Moreover, candidate 2 choosing policy B when having observed a signal N (i.e., $\sigma_2^N = 1$) must be a best response:

$$\left(1 - \sigma_3^{BB}\right) P_{B|N} \geq \left(1 - \sigma_3^{NN}\right) P_{N|N}. \tag{23}$$

Adding inequalities (22) and (23), using $P_{N|N} = 1 - P_{B|N}$ and $P_{B|B} = 1 - P_{N|B}$, and rewriting yield

$$\left(\sigma_3^{BB} + \sigma_3^{NN} - 2\right)\left(P_{B|B} - P_{B|N}\right) \geq 0. \tag{24}$$

Since $P_{B|B} > P_{N|B}$, inequality (24) can only be met if $\sigma_3^{BB} = \sigma_3^{NN} = 1$. Conversely, if we do have $\sigma_3^{BB} = \sigma_3^{BN} = \sigma_3^{NB} = \sigma_3^{NN} = 1$, then clearly none of the candidates has an incentive to deviate. This establishes the claim for case (iii). Case (iv) is analogous to case (iii) and is therefore omitted. Q.E.D.

We use the following three lemmas to characterize the babbling equilibria and prove Proposition 2.

Lemma A1. *In any babbling equilibrium in which $(x_1, x_2) = (B, N)$ (respectively, $(x_1, x_2) = (N, B)$) along the equilibrium path, one has $\sigma_3^{BN} = 1$ (respectively, $\sigma_3^{NB} = 0$).*

Proof: By definition, in a babbling equilibrium no information is revealed. Thus, the voter's posterior is equal to her prior. Hence the voter strictly prefers a candidate who has chosen platform B to a candidate who has chosen platform N. Q.E.D.

Lemma A2. *Suppose $q > 1 - \varepsilon$. Then, in any babbling equilibrium in which either $x_1 = B$ or $x_2 = N$ (respectively, either $x_1 = N$ or $x_2 = B$) along the equilibrium path, one has $\sigma_3^{BN} = 1$ (respectively, $\sigma_3^{NB} = 0$).*

Proof: For $q > 1 - \varepsilon$, the voter strictly prefers policy B if he knows at most one signal. Thus, independently of the beliefs the voter holds about the deviator's signal, she strictly prefers a candidate who has chosen platform B to a candidate who has chosen platform N. Q.E.D.

Lemma A3. *Suppose that $q \leq 1 - \varepsilon$ and that σ_3^{jk} is part of a babbling equilibrium in which $(x_1, x_2) = (j, k)$ only off the equilibrium path. Then there exist beliefs on the part of the voter that make any $\sigma_3^{jk} \in [0, 1]$ optimal for her.*

Proof: Since $(x_1, x_2) = (j, k)$ is off the equilibrium path at least one candidate deviated. The voter's beliefs about a deviator's signal are not determined by Bayes' rule. For $q \leq 1-\varepsilon$, there always exist beliefs for the voter about the deviator's signal such that she is indifferent between platforms B and N. Thus, any $\sigma_3^{jk} \in [0,1]$ satisfies the voter's incentive constraint for such beliefs. Q.E.D.

Proof of Proposition 2 In any babbling equilibrium in which the candidates play pure strategies on has $\sigma_i^B = \sigma_i^N = \sigma_i$ and $\sigma_i \in \{0,1\}$. Thus there are four cases to investigate: (i) $\sigma_1 = \sigma_2 = 1$; (ii) $\sigma_1 = 1$, $\sigma_2 = 0$; (iii) $\sigma_1 = \sigma_2 = 0$; (iv) $\sigma_1 = 0$, $\sigma_2 = 1$.

First consider case (i). From Lemma A2 we know that, for $q > 1-\varepsilon$, $\sigma_3^{NB} = 0$ and $\sigma_3^{BN} = 1$. From Lemma A3 we know that, for $q \leq 1-\varepsilon$, any $\sigma_3^{NB}, \sigma_3^{BN} \in [0,1]$ are consistent with the voter's incentive constraints being satisfied. Moreover, since the voter is always indifferent between the candidates when they have chosen the same platform, any $\sigma_3^{BB}, \sigma_3^{NN} \in [0,1]$ are consistent with the voter's incentive constraints being satisfied. In equilibrium, each candidate's choosing policy B (i.e., $\sigma_1 = \sigma_2 = 1$) must be a best response. This requires that $\sigma_3^{BB} \geq \sigma_3^{NB}$ and $1 - \sigma_3^{BB} \geq 1 - \sigma_3^{BN}$, or, equivalently, $\sigma_3^{NB} \leq \sigma_3^{BB} \leq \sigma_3^{BN}$. These inequalities are implied by $\sigma_3^{NB} = 0$ and $\sigma_3^{BN} = 1$. Thus, for $q \leq 1-\varepsilon$, case (i) is part of a babbling equilibrium iff $\sigma_3^{NB} \leq \sigma_3^{BB} \leq \sigma_3^{BN}$. And, for $q > 1-\varepsilon$, case (i) is part of a babbling equilibrium iff $\sigma_3^{NB} = 0$ and $\sigma_3^{BN} = 1$. Case (i) corresponds to part (a) of Proposition 2.

Consider case (ii). By Lemma A1, $\sigma_3^{BN} = 1$. Moreover, for any $q \in (1/2, \widetilde{q})$, any $\sigma_3^{BB}, \sigma_3^{NB}, \sigma_3^{NN} \in [0,1]$ are consistent with the voter's incentive constraints being satisfied. The reason why we can have any σ_3^{NB} for any q is that, at this information set, both candidates have deviated and, hence, the voter can hold any beliefs about both s_1 and s_2. In equilibrium, candidate 1's choosing policy B (i.e., $\sigma_1 = 1$) and candidate 2's choosing policy N ($\sigma_2 = 0$) must be a best response. That is, $\sigma_3^{BN} \geq \sigma_3^{NN}$ and $1 - \sigma_3^{BN} \geq 1 - \sigma_3^{BB}$. The latter inequality in conjunction with $\sigma_3^{BN} = 1$ imply $\sigma_3^{BB} = 1$; and, given $\sigma_3^{BN} = 1$, the first inequality is always satisfied. Hence, case (ii) is part of a babbling equilibrium iff $\sigma_3^{BB} = \sigma_3^{BN} = 1$. Case (ii) corresponds to part (b) of Proposition 2.

Consider case (iii). By Lemma A2, for $q > 1-\varepsilon$, $\sigma_3^{BN} = 1$ and $\sigma_3^{NB} = 0$. From Lemma A3 we know that, for $q \leq 1-\varepsilon$, any $\sigma_3^{NB}, \sigma_3^{BN} \in [0,1]$ are consistent with the voter's incentive constraints being satisfied. Moreover, for any $q \in (1/2, \widetilde{q})$, any $\sigma_3^{BB}, \sigma_3^{NN} \in [0,1]$ are consistent with the voter's incentive constraints being satisfied. In equilibrium, choosing policy N (i.e., $\sigma_1 = 0$ and $\sigma_2 = 0$) must be a best response for both candidates. That is, $\sigma_3^{NN} \geq \sigma_3^{BN}$ and $1 - \sigma_3^{NN} \geq 1 - \sigma_3^{NB}$. Hence, $\sigma_3^{BN} \leq \sigma_3^{NN} \leq \sigma_3^{NB}$. These inequalities are inconsistent with $\sigma_3^{NB} = 0$ and $\sigma_3^{BN} = 1$. Thus, for $q > 1 - \varepsilon$, case (iii) cannot be part of a babbling equilibrium. For $q \leq 1 - \varepsilon$, case (iii) is part of a babbling equilibrium iff $\sigma_3^{BN} \leq \sigma_3^{NN} \leq \sigma_3^{NB}$. Case (iii) corresponds to part (d) of Proposition 2. Case (iv), which corresponds to part (c) of Proposition 2, is analogous to case (ii) and therefore omitted. Q.E.D.

We use the following two lemmas to prove Proposition 4.

Lemma A4. *Condition 1 implies equations (6) and (7). Furthermore, if Condition 1a is satisfied then equations (6) and (7) imply Condition 1b.*

Proof: Let us first show that Condition 1 implies equations (6) and (7). Given that Condition 1a holds, Condition 1b and Bayes' rule (which is well defined if Condition 1a holds) imply that

$$\begin{aligned} &\Pr(\omega = \omega_B \mid x_1 = B, x_2 = N) \\ &= \frac{\Pr(x_1 = B, x_2 = N \mid \omega = B)\Pr(\omega = \omega_B)}{\sum_{j=B,N} \Pr(x_1 = B, x_2 = N \mid \omega = j)\Pr(\omega = \omega_j)} = \frac{1}{2}. \end{aligned} \tag{25}$$

Rewriting (25) we have

$$q \Pr(x_1 = B, x_2 = N \mid \omega = \omega_B) = (1 - q)\Pr(x_1 = B, x_2 = N \mid \omega = \omega_N). \tag{26}$$

We can also write

$$\begin{aligned} &\Pr(x_1 = B, x_2 = N \mid \omega = \omega_j) \\ &= \Pr(x_1 = B, x_2 = N \mid s_1 = B, s_2 = B)\Pr(s_1 = B, s_2 = B \mid \omega = \omega_j) \\ &+ \Pr(x_1 = B, x_2 = N \mid s_1 = B, s_2 = N)\Pr(s_1 = B, s_2 = N \mid \omega = \omega_j) \\ &+ \Pr(x_1 = B, x_2 = N \mid s_1 = N, s_2 = B)\Pr(s_1 = N, s_2 = B \mid \omega = \omega_j) \\ &+ \Pr(x_1 = B, x_2 = N \mid s_1 = N, s_2 = N)\Pr(s_1 = N, s_2 = N \mid \omega = \omega_j) \end{aligned} \tag{27}$$

for $j \in \{B, N\}$. Hence,

$$\begin{aligned}
&\Pr\left(x_1 = B, x_2 = N \mid \omega = \omega_B\right) \\
&= \sigma_1^B \left(1 - \sigma_2^B\right)(1-\varepsilon)^2 + \sigma_1^B \left(1 - \sigma_2^N\right)\varepsilon(1-\varepsilon) + \\
&\sigma_1^N \left(1 - \sigma_2^B\right)\varepsilon(1-\varepsilon) + \sigma_1^N \left(1 - \sigma_2^N\right)\varepsilon^2
\end{aligned} \tag{28}$$

and

$$\begin{aligned}
&\Pr\left(x_1 = B, x_2 = N \mid \omega = \omega_N\right) \\
&= \sigma_1^B \left(1 - \sigma_2^B\right)\varepsilon^2 + \sigma_1^B \left(1 - \sigma_2^N\right)\varepsilon(1-\varepsilon) + \\
&\sigma_1^N \left(1 - \sigma_2^B\right)\varepsilon(1-\varepsilon) + \sigma_1^N \left(1 - \sigma_2^N\right)(1-\varepsilon)^2 .
\end{aligned} \tag{29}$$

Substituting (28) and (29) into (26) and then rewriting (when one performs this algebra, the identity

$$\sigma_1^B \left(1 - \sigma_2^N\right) + \sigma_1^N \left(1 - \sigma_2^B\right) = \sigma_1^B \left(1 - \sigma_2^B\right) + \sigma_1^N \left(1 - \sigma_2^N\right) + \left(\sigma_1^B - \sigma_1^N\right)\left(\sigma_2^B - \sigma_2^N\right)$$

is very useful), one has equality (6). Similarly, Condition 1b also requires that $\Pr\left(\omega = B \mid x_1 = N, x_2 = B\right) = 1/2$ which (using Bayes' rule) can be rewritten as

$$q \Pr\left(x_1 = N, x_2 = B \mid \omega = \omega_B\right) = (1-q)\Pr\left(x_1 = N, x_2 = B \mid \omega = \omega_N\right). \tag{30}$$

Following the same procedure as above, (30) can in turn be rewritten as

$$\begin{aligned}
&\sigma_2^B \left(1 - \sigma_1^B\right)(q - \varepsilon) + \left(\sigma_1^B - \sigma_1^N\right)\left(\sigma_2^B - \sigma_2^N\right)\varepsilon(1-\varepsilon)(2q-1) \\
&= \sigma_2^N \left(1 - \sigma_1^N\right)(1 - \varepsilon - q).
\end{aligned} \tag{31}$$

Subtracting equality (31) from equality (6) yields equality (7). Hence, in an equilibrium that satisfies Condition 1 (i.e. Conditions 1a and 1b), equalities (6) and (7) must hold. It remains to show that if Condition 1a is satisfied then equalities (6) and (7) imply that Condition 1b is met. First, subtracting (7) from (6) yields (31). Moreover, (6) and (31) are just rewritten forms of (26) and (30), respectively. Hence, provided that Bayes' rule is well-defined (which it is if Condition 1a is satisfied), (6) and (7) imply Condition 1b. Q.E.D.

Lemma A5. *In any equilibrium satisfying Assumption 1 and Condition 1,* $\left(\sigma_1^B - \sigma_1^N\right)\left(\sigma_2^B - \sigma_2^N\right) > 0$.

Proof: From the proof of Lemma A4 we know that, in any equilibrium satisfying Condition 1, equation (26) must hold. Hence, since $q > 1/2$, we must have

$$\Pr(x_1 = B, x_2 = N \mid \omega = \omega_B) < \Pr(x_1 = B, x_2 = N \mid \omega = \omega_N). \qquad (32)$$

By using (28) and (29) in inequality (32) and then rewriting, we obtain

$$\sigma_1^B \left(1 - \sigma_2^B\right) < \sigma_1^N \left(1 - \sigma_2^N\right). \qquad (33)$$

Similarly, equation (30) and the fact that $q > 1/2$ imply that

$$\sigma_2^B \left(1 - \sigma_1^B\right) < \sigma_2^N \left(1 - \sigma_1^N\right). \qquad (34)$$

Inequality (33) implies that if $\sigma_2^B < \sigma_2^N$, then $\sigma_1^B < \sigma_1^N$; and inequality (34) implies that if $\sigma_1^B < \sigma_1^N$, then $\sigma_2^B < \sigma_2^N$. Hence, we must have $\left(\sigma_1^B - \sigma_1^N\right)\left(\sigma_2^B - \sigma_2^N\right) \geq 0$. It remains to show that we cannot have $\left(\sigma_1^B - \sigma_1^N\right)\left(\sigma_2^B - \sigma_2^N\right) = 0$. To see this, notice that if we use $\sigma_1^B = \sigma_1^N$ in (33) we get $\sigma_2^B > \sigma_2^N$ whereas $\sigma_1^B = \sigma_1^N$ in (34) gives us $\sigma_2^B < \sigma_2^N$; hence, $\sigma_1^B \neq \sigma_1^N$. A similar exercise for σ_2^B and σ_2^N gives us $\sigma_2^B \neq \sigma_2^N$. Q.E.D.

Proof of Proposition 4 Trivially, equilibria that satisfy Assumption 1 and Condition 1 exist only if $\sigma \in \Omega$. Conversely, if $\sigma \in \Omega$, then the voter is always indifferent between the candidates by Condition 1b. Thus, Assumption 1 implies that the candidates get elected with a given probability independent of their platform choices. Thus, all players' incentive constraints are satisfied if $\sigma \in \Omega$. It remains to show that Ω is non-empty if and only if $q < 1-\varepsilon$. The "if" part is easily proven by an example: if $q < 1-\varepsilon$, then $\sigma = (1, f(q,\varepsilon); 1, f(q,\varepsilon); \alpha, \alpha, \alpha, \alpha)$ belongs to Ω (see the text after Proposition 4). In order to prove the "only if" part, suppose that $q \geq 1-\varepsilon$. Then the right-hand side of (6) is less than or equal to zero. The left-hand side of (6), however, is by Lemma A5 strictly positive. Hence, equality (6) does not hold, which means (by Lemma A4) that the set Ω is empty. Q.E.D.

We use the following lemma to prove Proposition 5.

Lemma A6. *If Condition 1 is met, the voter's expected utility can be written*

$$\begin{aligned} EU_{mix} &= \sigma_1^B (q-\varepsilon) - \sigma_1^N (1-\varepsilon-q) + 1 - q \\ &= \sigma_2^B (q-\varepsilon) - \sigma_2^N (1-\varepsilon-q) + 1 - q. \end{aligned}$$

Proof: Since Condition 1 is met, Lemma A4 implies that equation (7) is satisfied. It follows from equation (7) that the first line in the above equation is identical to the second. Conditioning on the true state ω, one can write

$$\begin{aligned} &EU_{mix} \\ &= q \left[\begin{array}{c} \Pr(x_1 = B, x_2 = B \mid \omega = \omega_B) + \sigma_3^{BN} \Pr(x_1 = B, x_2 = N \mid \omega = \omega_B) \\ + \left(1 - \sigma_3^{NB}\right) \Pr(x_1 = N, x_2 = B \mid \omega = \omega_B) \end{array} \right] + \\ &(1-q) \left[\begin{array}{c} \left(1 - \sigma_3^{BN}\right) \Pr(x_1 = B, x_2 = N \mid \omega = \omega_N) + \\ \sigma_3^{NB} \Pr(x_1 = N, x_2 = B \mid \omega = \omega_N) + \Pr(x_1 = N, x_2 = N \mid \omega = \omega_N) \end{array} \right]. \end{aligned}$$

It follows from the proof of Lemma A4 that Condition 1 requires that (26) and (30) hold. Using the equalities (26) and (30) to rewrite the above equation one obtains

$$\begin{aligned} EU_{mix} = {} & q \left[\Pr(x_1 = B, x_2 = B \mid \omega = \omega_B) + \Pr(x_1 = N, x_2 = B \mid \omega = \omega_B)\right] + \\ & (1-q) \left[\Pr(x_1 = B, x_2 = N \mid \omega = \omega_N) + \Pr(x_1 = N, x_2 = N \mid \omega = \omega_N)\right]. \end{aligned}$$

This equation simplifies to

$$\begin{aligned} EU_{mix} &= q \Pr(x_2 = B \mid \omega = \omega_B) + (1-q) \Pr(x_2 = N \mid \omega = \omega_N) \\ &= q \left[\sigma_2^B (1-\varepsilon) + \sigma_2^N \varepsilon\right] + (1-q) \left[\left(1-\sigma_2^B\right) \varepsilon + \left(1-\sigma_2^N\right)(1-\varepsilon)\right] \\ &= \sigma_2^B (q-\varepsilon) - \sigma_2^N (1-\varepsilon-q) + 1 - q. \end{aligned}$$

Q.E.D.

Proof of Proposition 5 For $\sigma \in \Omega$, the voter is always indifferent between the candidates by Condition 1b. Hence, Assumption 1 implies that the candidates are indifferent between all equilibria that satisfy $\sigma \in \Omega$. Thus, to prove that the equilibrium outcome where $\sigma = (1, f(q,\varepsilon); 1, f(q,\varepsilon); \alpha, \alpha, \alpha, \alpha)$ Pareto dominates all other equilibria that satisfy $\sigma \in \Omega$, it suffices to show that this equilibrium outcome maximizes the voter's expected welfare. Lemma A6 implies that this is identical to showing that $\left(\sigma_1^B, \sigma_1^N, \sigma_2^B, \sigma_2^N\right) = (1, f(q,\varepsilon), 1, f(q,\varepsilon))$

solves the following problem:

$$\max_{\sigma_1^B,\sigma_1^N,\sigma_2^B,\sigma_2^N} \frac{\sigma_1^B+\sigma_2^B}{2}(q-\varepsilon)-\frac{\sigma_1^N+\sigma_2^N}{2}(1-\varepsilon-q)$$

subject to (6), (7), and $\sigma_1^B,\sigma_1^N,\sigma_2^B,\sigma_2^N \in [0,1]$.

It is useful to note that the value of the objective function at the point $\left(\sigma_1^B,\sigma_1^N,\sigma_2^B,\sigma_2^N\right)=(1,f(q,\varepsilon),1,f(q,\varepsilon))$ is

$$q-\varepsilon-f(q,\varepsilon)(1-\varepsilon-q)>0,$$

since $q-\varepsilon>1-\varepsilon-q$. Hence, since $\left(\sigma_1^B,\sigma_1^N,\sigma_2^B,\sigma_2^N\right)=(1,f(q,\varepsilon),1,f(q,\varepsilon))$ satisfies the constraints (6) and (7), the value of the objective function evaluated at the solution of the maximization problem is positive. In particular, since Lemma A6 implies that the objective function can be rewritten as $\sigma_i^B(q-\varepsilon)-\sigma_i^N(1-\varepsilon-q)$, this rules out that $\sigma_i^B=0$ for $i=\{1,2\}$. Furthermore, one may rule out that $\sigma_i^N=1$ since

$$q-\varepsilon-f(q,\varepsilon)(1-\varepsilon-q)>\sigma_i^B(q-\varepsilon)-(1-\varepsilon-q).$$

In the following we will set up the Lagrangian for the above maximization problem and show that no other candidate solution for a maximum exists besides $\left(\sigma_1^B,\sigma_1^N,\sigma_2^B,\sigma_2^N\right)=(1,f(q,\varepsilon),1,f(q,\varepsilon))$, thereby proving that this indeed is the maximum. In order to set up the Lagrangian it is useful to rewrite (6) as

$$\begin{aligned}&\sigma_1^B\left(1-\sigma_2^B\right)\left[(1-\varepsilon)^2q-\varepsilon^2(1-q)\right]\\&+\left[\sigma_1^B\left(1-\sigma_2^N\right)+\sigma_1^N\left(1-\sigma_2^B\right)\right]\varepsilon(1-\varepsilon)(2q-1)\\&=\sigma_1^N\left(1-\sigma_2^N\right)\left[(1-\varepsilon)^2(1-q)-\varepsilon^2q\right].\end{aligned}\tag{35}$$

The Lagrangian can thus be written as

$$\begin{aligned}\mathcal{L}=&\frac{\sigma_1^B+\sigma_2^B}{2}(q-\varepsilon)-\frac{\sigma_1^N+\sigma_2^N}{2}(1-\varepsilon-q)\\&-\lambda\left[\begin{array}{c}\sigma_1^B\left(1-\sigma_2^B\right)\left[(1-\varepsilon)^2q-\varepsilon^2(1-q)\right]\\+\left[\sigma_1^B\left(1-\sigma_2^N\right)+\sigma_1^N\left(1-\sigma_2^B\right)\right]\varepsilon(1-\varepsilon)(2q-1)\\-\sigma_1^N\left(1-\sigma_2^N\right)\left[(1-\varepsilon)^2(1-q)-\varepsilon^2q\right]\end{array}\right]\\&-\mu\left[\left(\sigma_1^B-\sigma_2^B\right)(q-\varepsilon)-\left(\sigma_1^N-\sigma_2^N\right)(1-\varepsilon-q)\right]\\&+\theta_1^B\left(1-\sigma_1^B\right)+\theta_2^B\left(1-\sigma_2^B\right)+\theta_1^N\sigma_1^N+\theta_2^N\sigma_2^N.\end{aligned}$$

A necessary condition for a maximum is that the following first-order conditions are satisfied:

$$\frac{\partial \mathcal{L}}{\partial \sigma_2^B} = 0 = \frac{q-\varepsilon}{2} - \lambda\{-\sigma_1^B \left[(1-\varepsilon)^2 q - \varepsilon^2 (1-q)\right] - \sigma_1^N \varepsilon (1-\varepsilon)(2q-1)\} + \mu (q-\varepsilon) - \theta_2^B, \tag{36}$$

$$\frac{\partial \mathcal{L}}{\partial \sigma_2^N} = 0 = -\frac{(1-\varepsilon-q)}{2} - \lambda\{-\sigma_1^B \varepsilon (1-\varepsilon)(2q-1) + \sigma_1^N \left[(1-\varepsilon)^2 (1-q) - \varepsilon^2 q\right]\} - \mu (1-\varepsilon-q) + \theta_2^N. \tag{37}$$

Since we have ruled out that either $\sigma_i^B = 0$ or $\sigma_i^N = 1$ for $i = \{1,2\}$, we are left to check the following cases for candidate solutions: (1) $\sigma_1^B, \sigma_1^N, \sigma_2^B, \sigma_2^N \in (0,1)$; (2) $\sigma_1^B = 1$ and $\sigma_1^N, \sigma_2^B, \sigma_2^N \in (0,1)$; (2') $\sigma_2^B = 1$ and $\sigma_1^B, \sigma_1^N, \sigma_2^N \in (0,1)$; (3) $\sigma_1^N = 0$ and $\sigma_1^B, \sigma_2^B, \sigma_2^N \in (0,1)$; (3') $\sigma_2^N = 0$ and $\sigma_1^B, \sigma_1^N, \sigma_2^B \in (0,1)$; (4) $\sigma_1^B = 1$, $\sigma_1^N = 0$, and $\sigma_2^B, \sigma_2^N \in (0,1)$; (4') $\sigma_2^B = 1$, $\sigma_2^N = 0$, and $\sigma_1^B, \sigma_1^N \in (0,1)$; (5) $\sigma_1^N = 0$, $\sigma_2^B = 1$, and $\sigma_1^B, \sigma_2^N \in (0,1)$; (5') $\sigma_1^B = 1$, $\sigma_2^N = 0$, and $\sigma_1^N, \sigma_2^B \in (0,1)$; (6) $\sigma_1^B = \sigma_2^B = 1$ and $\sigma_1^N, \sigma_2^N \in (0,1)$; (7) $\sigma_1^N = \sigma_2^N = 0$ and $\sigma_1^B, \sigma_2^B \in (0,1)$; (8) $\sigma_1^B = \sigma_2^B = 1$, $\sigma_1^N = 0$ and $\sigma_2^N \in (0,1)$; (8') $\sigma_1^B = \sigma_2^B = 1$, $\sigma_2^N = 0$ and $\sigma_1^N \in (0,1)$; (9) $\sigma_1^N = \sigma_2^N = 0$, $\sigma_1^B = 1$ and $\sigma_2^B \in (0,1)$; (9')$\sigma_1^N = \sigma_2^N = 0$, $\sigma_2^B = 1$ and $\sigma_1^B \in (0,1)$. It is easy to see that cases (2')-(5'), (8'), and (9') are symmetric to the corresponding cases (2)-(5), (8), and (9) and therefore we will omit them below.

In the following, we show that the only candidate solution belongs to case (6); furthermore, this solution is $\left(\sigma_1^B, \sigma_1^N, \sigma_2^B, \sigma_2^N\right) = (1, f(q,\varepsilon), 1, f(q,\varepsilon))$. Below, we use the fact that if $\sigma_i^j \in (0,1)$ then $\theta_i^j = 0$.

Cases 1-4: Here one has $\theta_2^B = \theta_2^N = 0$. Rewriting equations (36) and (37) in matrix form, using the fact that $\theta_2^B = \theta_2^N = 0$, gives

$$\begin{pmatrix} \left[(1-\varepsilon)^2 q - \varepsilon^2 (1-q)\right] & \varepsilon (1-\varepsilon)(2q-1) \\ \varepsilon (1-\varepsilon)(2q-1) & -\left[(1-\varepsilon)^2 (1-q) - \varepsilon^2 q\right] \end{pmatrix} \begin{pmatrix} \sigma_1^B \\ \sigma_1^N \end{pmatrix} = \begin{pmatrix} -\frac{1+2\mu}{2\lambda}(q-\varepsilon) \\ \frac{1+2\mu}{2\lambda}(1-\varepsilon-q) \end{pmatrix}.$$

Applying Cramer's rule, one has that $\sigma_1^B = \sigma_1^N$ if

$$\frac{1+2\mu}{2\lambda}(q-\varepsilon)\left[(1-\varepsilon)^2 (1-q) - \varepsilon^2 q\right] - \frac{1+2\mu}{2\lambda}(1-\varepsilon-q)\,\varepsilon(1-\varepsilon)(2q-1)$$
$$= \frac{1+2\mu}{2\lambda}(1-\varepsilon-q)\left[(1-\varepsilon)^2 q - \varepsilon^2 (1-q)\right] + \frac{1+2\mu}{2\lambda}(q-\varepsilon)\,\varepsilon(1-\varepsilon)(2q-1).$$

This equation holds if

$$(q-\varepsilon)\left\{\left[(1-\varepsilon)^2(1-q)-\varepsilon^2 q\right]-\varepsilon(1-\varepsilon)(2q-1)\right\}$$
$$=(1-\varepsilon-q)\left\{\left[(1-\varepsilon)^2 q-\varepsilon^2(1-q)\right]+\varepsilon(1-\varepsilon)(2q-1)\right\},$$

which simplifies to $(q-\varepsilon)(1-\varepsilon-q)=(1-\varepsilon-q)(q-\varepsilon)$. Hence, if $\theta_2^B=\theta_2^N=0$, then $\sigma_1^B=\sigma_1^N$, which contradicts Lemma A5.

Case 5: Using $\sigma_2^B=1$ and $\sigma_1^N=0$, the constraint (35) simplifies to

$$\sigma_1^B\left(1-\sigma_2^N\right)\varepsilon(1-\varepsilon)(2q-1)=0.$$

This equality, however, contradicts $\sigma_1^B,\sigma_2^N\in(0,1)$ since $q>1/2$.

Case 6: Using $\sigma_1^B=\sigma_2^B=1$ in the constraint (7), one has $\sigma_1^N=\sigma_2^N=\sigma^N$. Next, by using $\sigma_1^B=\sigma_2^B=1$ and $\sigma_1^N=\sigma_2^N=\sigma^N$ in the constraint (35), we can solve for $\sigma^N=f(q,\varepsilon)$. Hence, the point $\left(\sigma_1^B,\sigma_1^N,\sigma_2^B,\sigma_2^N\right)=(1,f(q,\varepsilon),1,f(q,\varepsilon))$ is one candidate for the maximum.

Case 7: Substituting $\sigma_1^N=\sigma_2^N=0$ into the constraint (35), gives

$$\sigma_1^B\left(1-\sigma_2^B\right)\left[(1-\varepsilon)^2 q-\varepsilon^2(1-q)\right]+\sigma_1^B\varepsilon(1-\varepsilon)(2q-1)=0.$$

This equality, however, contradicts $\sigma_1^B\in(0,1)$.

Case 8: Using $\sigma_1^B=\sigma_2^B=1$ and $\sigma_1^N=0$, the constraint (7) simplifies to $-\sigma_2^N(1-\varepsilon-q)=0$, which contradicts $\sigma_2^N\in(0,1)$.

Case 9: Using $\sigma_1^B=1$ and $\sigma_1^N=\sigma_2^N=0$, the constraint (7) simplifies to $\left(1-\sigma_2^B\right)(q-\varepsilon)=0$, which contradicts $\sigma_2^B\in(0,1)$.

Hence, $\left(\sigma_1^B,\sigma_1^N,\sigma_2^B,\sigma_2^N\right)=(1,f(q,\varepsilon),1,f(q,\varepsilon))$ is the only candidate for an extremum. Since we know that it is not a minimum, it must be a maximum. Q.E.D.

Proof of Claim 1

Claim 1. *EU_{PR}^f is (for any $q<1-\varepsilon$) convex in q: $\partial^2 EU_{PR}^f/\partial q^2>0$.*

Proof: Differentiating EU_{PR}^f in (10) twice with respect to q yields

$$\frac{\partial^2 EU_{PR}^f}{\partial q^2}=2\frac{\partial f(q,\varepsilon)}{\partial q}-\frac{\partial^2 f(q,\varepsilon)}{\partial q^2}(1-\varepsilon-q)\,. \tag{38}$$

Differentiating f in (9) twice with respect to q gives

$$\frac{\partial^2 f(q,\varepsilon)}{\partial q^2}=\frac{2[(1-\varepsilon)^2+\varepsilon^2]}{[(1-\varepsilon)^2(1-q)-\varepsilon^2 q]}\frac{\partial f(q,\varepsilon)}{\partial q}. \tag{39}$$

Substituting (39) into (38) and then simplifying yield

$$\frac{\partial^2 EU_{PR}^f}{\partial q^2} = 2[(1-\varepsilon)^2 (1-q) - \varepsilon^2 q] \left[\frac{\partial f(q,\varepsilon)}{\partial q}\right]^2, \qquad (40)$$

which is strictly positive for $q < 1 - \varepsilon$. Q.E.D.

Proof of Proposition 6 Let Assumption 1 be satisfied. We start with the following simple observation.

Lemma A7. *Suppose that either (i) $\sigma_i^B = \sigma_i^N = 1$ or (ii) $\sigma_i^B = \sigma_i^N = 0$. Then, if the voter's updated beliefs after having observed one platform B and one platform N put equal weights on the state being B and the state being N, the voter's expected welfare is equal to either (i) the popular-beliefs or (ii) the bad babbling equilibrium. Furthermore in equilibrium, candidate 1 gets elected with probability α.*

Proof: Since the voter is always indifferent between the candidates, her expected welfare is independent of which candidate she elects. Since candidate i plays a pure babbling strategy, the voter's expected welfare is equal to the welfare in either babbling equilibria. Furthermore, since the voter is always indifferent between the candidates, Assumption 1 implies that candidate 1 is elected with probability α. Q.E.D.

Hence, in all equilibria in which the voter is always indifferent between the candidates and in which Condition 1 is not satisfied, the voter's expected welfare is equal to either the expected welfare she gets in the popular-beliefs or the bad babbling equilibria. Furthermore, in any such equilibrium candidate 1 is elected with probability α. Thus, to prove Proposition 6, we are left to consider all equilibria in which at least one candidate plays a (strictly) mixed strategy and the voter is not always indifferent between the candidates. Any such equilibrium must belong to one of the nine categories indicated in the following figure (the rows belong to candidate 1 and the columns belong to candidate 2).

mix?	none	B	N	both
none	$---$	$---$	$---$	$---$
B	1	4	$---$	$---$
N	2	5	6	$---$
both	3	7	8	9

The cases above the diagonal are symmetric to the ones below the diagonal and we therefore simply omit them. In other words, the remaining mixed strategy profiles must fall into one of the following nine categories: (1) $\sigma_1^B \in (0,1)$ and $\sigma_1^N, \sigma_2^B, \sigma_2^N \in \{0,1\}$; (2) $\sigma_1^N \in (0,1)$ and $\sigma_1^B, \sigma_2^B, \sigma_2^N \in \{0,1\}$; (3) $\sigma_1^B, \sigma_1^N \in (0,1)$ and $\sigma_2^B, \sigma_2^N \in \{0,1\}$; (4) $\sigma_1^B, \sigma_2^B \in (0,1)$ and $\sigma_1^N, \sigma_2^N \in \{0,1\}$; (5) $\sigma_1^N, \sigma_2^B \in (0,1)$ and $\sigma_1^B, \sigma_2^N \in \{0,1\}$; (6) $\sigma_1^N, \sigma_2^N \in (0,1)$ and $\sigma_1^B, \sigma_2^B \in \{0,1\}$; (7) $\sigma_1^B, \sigma_1^N, \sigma_2^B \in (0,1)$ and $\sigma_2^N \in \{0,1\}$; (8) $\sigma_1^B, \sigma_1^N, \sigma_2^N \in (0,1)$ and $\sigma_2^B \in \{0,1\}$; (9) $\sigma_1^B, \sigma_1^N, \sigma_2^B, \sigma_2^N \in (0,1)$.

Before considering each individual category it is useful to write down candidate 1's incentive constraints and establish some simple but powerful lemmas. Let

$$\begin{aligned} h_1^B &= \sigma_3^{BB}\left[P_{B|B}\sigma_2^B + P_{N|B}\sigma_2^N\right] + \sigma_3^{BN}\left[P_{B|B}(1-\sigma_2^B) + P_{N|B}\left(1-\sigma_2^N\right)\right] \\ &\quad - \sigma_3^{NB}\left[P_{B|B}\sigma_2^B + P_{N|B}\sigma_2^N\right] - \sigma_3^{NN}\left[P_{B|B}(1-\sigma_2^B) + P_{N|B}\left(1-\sigma_2^N\right)\right], \end{aligned}$$

$$\begin{aligned} h_1^N &= \sigma_3^{BB}\left[P_{B|N}\sigma_2^B + P_{N|N}\sigma_2^N\right] + \sigma_3^{BN}\left[P_{B|N}(1-\sigma_2^B) + P_{N|N}\left(1-\sigma_2^N\right)\right] \\ &\quad - \sigma_3^{NB}\left[P_{B|N}\sigma_2^B + P_{N|N}\sigma_2^N\right] - \sigma_3^{NN}\left[P_{B|N}(1-\sigma_2^B) + P_{N|N}\left(1-\sigma_2^N\right)\right]. \end{aligned}$$

If $\sigma_1^B = 1$, then candidate 1 must weakly prefer to announce B when observing a signal B. Thus, if $\sigma_1^B = 1$ (respectively, if $\sigma_1^B = 0$) then $h_1^B \geq 0$ (respectively, $h_1^B \leq 0$). Furthermore, if $\sigma_1^B \in (0,1)$, then $h_1^B = 0$. Similarly, if $\sigma_1^N = 1$ (respectively, if $\sigma_1^N = 0$) then $h_1^N \geq 0$ (respectively, $h_1^N \leq 0$). Finally, if $\sigma_1^N \in (0,1)$, then $h_1^N = 0$. Rewriting the above equations (using $\sigma_3^{BB} = \sigma_3^{NN} = \alpha$ from Assumption 1) yields

$$\begin{aligned} h_1^B &= (\alpha - \sigma_3^{NB})\left[P_{B|B}\sigma_2^B + P_{N|B}\sigma_2^N\right] \\ &\quad - (\alpha - \sigma_3^{BN})\left[P_{B|B}(1-\sigma_2^B) + P_{N|B}\left(1-\sigma_2^N\right)\right], \end{aligned} \tag{41}$$

$$\begin{aligned} h_1^N &= (\alpha - \sigma_3^{NB})\left[P_{B|N}\sigma_2^B + P_{N|N}\sigma_2^N\right] \\ &\quad - (\alpha - \sigma_3^{BN})\left[P_{B|N}(1-\sigma_2^B) + P_{N|N}\left(1-\sigma_2^N\right)\right]. \end{aligned} \tag{42}$$

(The corresponding functions for candidate 2, h_2^B and h_2^N, which will be used later, are defined in a similar way.) Equations (41) and (42) enable us to establish the following four lemmas.

Lemma A8. *Suppose that either* $\sigma_1^B \in (0,1)$ *or* $\sigma_1^N \in (0,1)$ *(or both:* $\sigma_1^B, \sigma_1^N \in (0,1)$*). If* $\sigma_3^{NB} \in \{0,1\}$*, then* $\sigma_3^{BN} \neq 1 - \sigma_3^{NB}$.

Proof: Since either $h_1^B = 0$ or $h_1^N = 0$, substituting $\sigma_3^{NB} \in \{0,1\}$ into (41) or (42) yields the result. Q.E.D.

Lemma A9. *Suppose that either* $\sigma_1^B \in (0,1)$ *or* $\sigma_1^N \in (0,1)$ *(or both:* $\sigma_1^B, \sigma_1^N \in (0,1)$*). If* $\sigma_3^{NB} \in \{0,1\}$ *and* $\sigma_3^{BN} = \alpha$*, then the voter's expected welfare is equal to her expected welfare in the bad babbling equilibrium. Furthermore, in such an equilibrium candidate 1 gets elected with probability* α.

Proof: Since either $h_1^B = 0$ or $h_1^N = 0$, substituting $\sigma_3^{NB} \in \{0,1\}$ and $\sigma_3^{BN} = \alpha$ into (41) or (42) yields $\sigma_2^B = \sigma_2^N = 0$. From $\sigma_3^{BN} = \alpha$ and $\sigma_2^B = \sigma_2^N = 0$ it follows that the voter is always indifferent between the candidates along the equilibrium path; hence her expected welfare is identical to the expected welfare she would get by always electing candidate 2, who is babbling on N. In addition, because the voter is indifferent between the candidates, Assumption 1 implies that candidate 1 gets elected with probability α. Q.E.D.

Lemma A10. *Suppose that either* $\sigma_1^B \in (0,1)$ *or* $\sigma_1^N \in (0,1)$ *(or both:* $\sigma_1^B, \sigma_1^N \in (0,1)$*). If* $\sigma_3^{BN} \in \{0,1\}$ *and* $\sigma_3^{NB} = \alpha$*, then the voter's expected welfare is equal to her expected welfare in the popular-beliefs equilibrium. Furthermore, in such an equilibrium candidate 1 gets elected with probability* α.

Proof: Since either $h_1^B = 0$ or $h_1^N = 0$, substituting $\sigma_3^{BN} \in \{0,1\}$ *and* $\sigma_3^{NB} = \alpha$ into (41) or (42) yields $\sigma_2^B = \sigma_2^N = 1$. From $\sigma_3^{NB} = \alpha$ and $\sigma_2^B = \sigma_2^N = 1$ it follows that the voter is always indifferent between the candidates along the equilibrium path; hence her expected welfare is identical to the expected welfare she would get by always electing candidate 2, who is babbling on B. In addition, because the voter is indifferent between the candidates, Assumption 1 implies that candidate 1 gets elected with probability α. Q.E.D.

Lemma A11. *Suppose that* $\sigma_1^B \in (0,1)$ *and* $\sigma_1^N \in (0,1)$*. If* $\sigma_3^{BN} = \sigma_3^{NB} \in \{0,1\}$*, then* $\sigma_2^B = \sigma_2^N = 1/2$.

Proof: Since both $h_1^B = 0$ and $h_1^N = 0$, substituting $\sigma_3^{BN} = \sigma_3^{NB} \neq \alpha$ into (41) and (42) and rewriting gives

$$2\sigma_2^B - 1 = \frac{P_{N|B}}{P_{B|B}} \left(1 - 2\sigma_2^N\right),$$

$$2\sigma_2^B - 1 = \frac{P_{N|N}}{P_{B|N}} \left(1 - 2\sigma_2^N\right).$$

Since, however, $P_{N|B}/P_{B|B} < P_{N|N}/P_{B|N}$, these equations imply that $\sigma_2^B = \sigma_2^N = 1/2$. Q.E.D.

When we go through the different categories, we will do this by considering four different subcases (see also the figure below): (i) $\left(\sigma_3^{BN}, \sigma_3^{NB}\right) = (\alpha, 0)$ or $\left(\sigma_3^{BN}, \sigma_3^{NB}\right) = (\alpha, 1)$; (ii) $\left(\sigma_3^{BN}, \sigma_3^{NB}\right) = (0, \alpha)$ or $\left(\sigma_3^{BN}, \sigma_3^{NB}\right) = (1, \alpha)$; (iii) $\left(\sigma_3^{BN}, \sigma_3^{NB}\right) = (1, 0)$ or $\left(\sigma_3^{BN}, \sigma_3^{NB}\right) = (0, 1)$; (iv) $\left(\sigma_3^{BN}, \sigma_3^{NB}\right) = (0, 0)$ or $\left(\sigma_3^{BN}, \sigma_3^{NB}\right) = (1, 1)$. For each subcase we will show that either an equilibrium cannot exist ("no equilibrium"), any equilibrium gives the voter the expected welfare of a bad babbling equilibrium ("bad welfare"), or any equilibrium gives the voter the expected welfare of a popular-beliefs equilibrium ("popular-beliefs welfare"). Furthermore, if an equilibrium exists candidate 1 gets elected with probability α.

$\sigma_3^{BN} \backslash \sigma_3^{NB}$	0	α	1
0	(iv)	(ii)	(iii)
α	(i)	$---$	(i)
1	(iii)	(ii)	(iv)

Let us first note that for subcase (i) and all nine categories, Lemma A9 implies bad welfare and that candidate 1 gets elected with probability α. Similarly, for subcase (ii) and all nine categories, Lemma A10 implies popular-beliefs welfare and that candidate 1 gets elected with probability α. Moreover, for subcase (iii) and all nine categories, Lemma A8 implies no equilibrium.

By going through all nine categories one by one, we now show that, for subcase (iv), we must have no equilibrium.

Category 1: $\sigma_3^{BN} = \sigma_3^{NB} \neq \alpha$, $h_1^B = 0$, and equation (41) imply that

$$2\sigma_2^B - 1 = \frac{P_{N|B}}{P_{B|B}} \left(1 - 2\sigma_2^N\right). \tag{43}$$

This, however, contradicts $\sigma_2^B, \sigma_2^N \in \{0, 1\}$.

Category 2: $\sigma_3^{BN} = \sigma_3^{NB} \neq \alpha$, $h_1^N = 0$, and equation (42) imply $P_{B|N}(2\sigma_2^B - 1) = P_{N|N}\left(1 - 2\sigma_2^N\right)$. Again, this contradicts $\sigma_2^B, \sigma_2^N \in \{0, 1\}$.

Category 3: The same argument as for subcase (iv) of either Category 1 or 2 applies.

Category 4: $\sigma_1^B, \sigma_2^B \in (0, 1)$ implies that $h_1^B = h_2^B = 0$. These equalities in conjunction with $\sigma_3^{BN} = \sigma_3^{NB} \neq \alpha$ imply that

$$2\sigma_i^B - 1 = \frac{P_{N|B}}{P_{B|B}}\left(1 - 2\sigma_i^N\right), \tag{44}$$

for $i = 1, 2$. To start with, suppose $\sigma_1^N = \sigma_2^N$. Then equation (44) implies $\sigma_1^B = \sigma_2^B$. If, however, the candidates' strategies are symmetric, then whenever $\sigma_3^{NB} \in \{0, 1\}$ it must be that $\sigma_3^{BN} = 1 - \sigma_3^{NB}$, which contradicts $\sigma_3^{BN} = \sigma_3^{NB}$. Now suppose $\sigma_1^N \neq \sigma_2^N$; in particular and without loss of generality, consider the case $\left(\sigma_1^N, \sigma_2^N\right) = (1, 0)$. This together with $\sigma_1^B, \sigma_2^B \in (0, 1)$ imply: if $(x_1, x_2) = (N, B)$, then the voter infers that $(s_1, s_2) = (B, B)$. Hence, $\sigma_3^{NB} = 0$. Thus $\sigma_3^{BN} = \sigma_3^{NB} = 0$. One has also that $P_{N|N}/P_{B|N} > P_{N|B}/P_{B|B}$. From this inequality and the fact that for $\sigma_2^N = 0$ both sides of (44) are positive, we get

$$2\sigma_2^B - 1 < \frac{P_{N|N}}{P_{B|N}}\left(1 - 2\sigma_2^N\right),$$

which together with $\sigma_3^{BN} = \sigma_3^{NB} = 0$ imply that $h_1^N < 0$. This is an impossibility, however, since $\sigma_1^N = 1$ requires that $h_1^N \geq 0$.

Category 5: $\sigma_2^B \in (0, 1)$ implies that $h_2^B = 0$. This equality in conjunction with $\sigma_3^{BN} = \sigma_3^{NB} \neq \alpha$ imply that (44) holds for $i = 1$. Substituting $\sigma_1^B = 0$ respectively $\sigma_1^B = 1$ into (44) for $i = 1$ yields $\sigma_1^N = 1/(2P_{N|B})$ respectively $\sigma_1^N = \left(P_{N|B} - P_{B|B}\right)/(2P_{N|B})$. Since $P_{N|B} < 1/2$ and $P_{N|B} < P_{B|B}$, however, this contradicts $\sigma_1^N \in (0, 1)$.

Category 6: $\sigma_1^N, \sigma_2^N \in (0, 1)$ implies that $h_1^N = h_2^N = 0$. These equalities in conjunction with $\sigma_3^{BN} = \sigma_3^{NB} \neq \alpha$ imply that

$$2\sigma_i^B - 1 = \frac{P_{N|N}}{P_{B|N}}\left(1 - 2\sigma_i^N\right), \tag{45}$$

for $i = 1, 2$. To start with, suppose $\sigma_1^B = \sigma_2^B$. Then equation (45) implies $\sigma_1^N = \sigma_2^N$. If, however, the candidates' strategies are symmetric, then whenever $\sigma_3^{NB} \in \{0, 1\}$ it must be that $\sigma_3^{BN} = 1 - \sigma_3^{NB}$, which contradicts $\sigma_3^{BN} = \sigma_3^{NB}$. Now suppose $\sigma_1^B \neq \sigma_2^B$; in particular and without loss of generality, consider the case $\left(\sigma_1^B, \sigma_2^B\right) = (0,1)$. This together with $\sigma_1^N, \sigma_2^N \in (0,1)$ imply: if $(x_1, x_2) = (B, N)$, then the voter infers that $(s_1, s_2) = (N, N)$. Hence, $\sigma_3^{BN} = 0$. Thus $\sigma_3^{BN} = \sigma_3^{NB} = 0$. One has also that $P_{N|N}/P_{B|N} > P_{N|B}/P_{B|B}$. From this inequality and the fact that for $\sigma_2^B = 1$ both sides of (45) are positive, we get

$$2\sigma_2^B - 1 > \frac{P_{N|B}}{P_{B|B}} \left(1 - 2\sigma_2^N\right),$$

which together with $\sigma_3^{BN} = \sigma_3^{NB} = 0$ imply that $h_1^B > 0$. This is an impossibility, however, since $\sigma_1^B = 0$ requires that $h_1^B \leq 0$.

Categories 7 and 8: From $\sigma_1^B, \sigma_1^N \in (0,1)$, $\sigma_3^{BN} = \sigma_3^{NB} \neq \alpha$, and Lemma A11 it follows that $\sigma_2^B = \sigma_2^N = 1/2$. This contradicts, however, that $\sigma_2^N \in \{0,1\}$ respectively $\sigma_2^B \in \{0,1\}$.

Category 9: From $\sigma_1^B, \sigma_1^N \in (0,1)$, $\sigma_3^{BN} = \sigma_3^{NB} \neq \alpha$, and Lemma A11 it follows that $\sigma_2^B = \sigma_2^N = 1/2$. Since the argument in the proof of Lemma A11 is symmetric across candidate 1 and 2, we also have $\sigma_1^B = \sigma_1^N = 1/2$. Hence, since both candidates babble we must have $\sigma_3^{BN} = 1$ and $\sigma_3^{NB} = 0$, which contradicts $\sigma_3^{BN} = \sigma_3^{NB}$.

This completes the proof of Proposition 6. Q.E.D.

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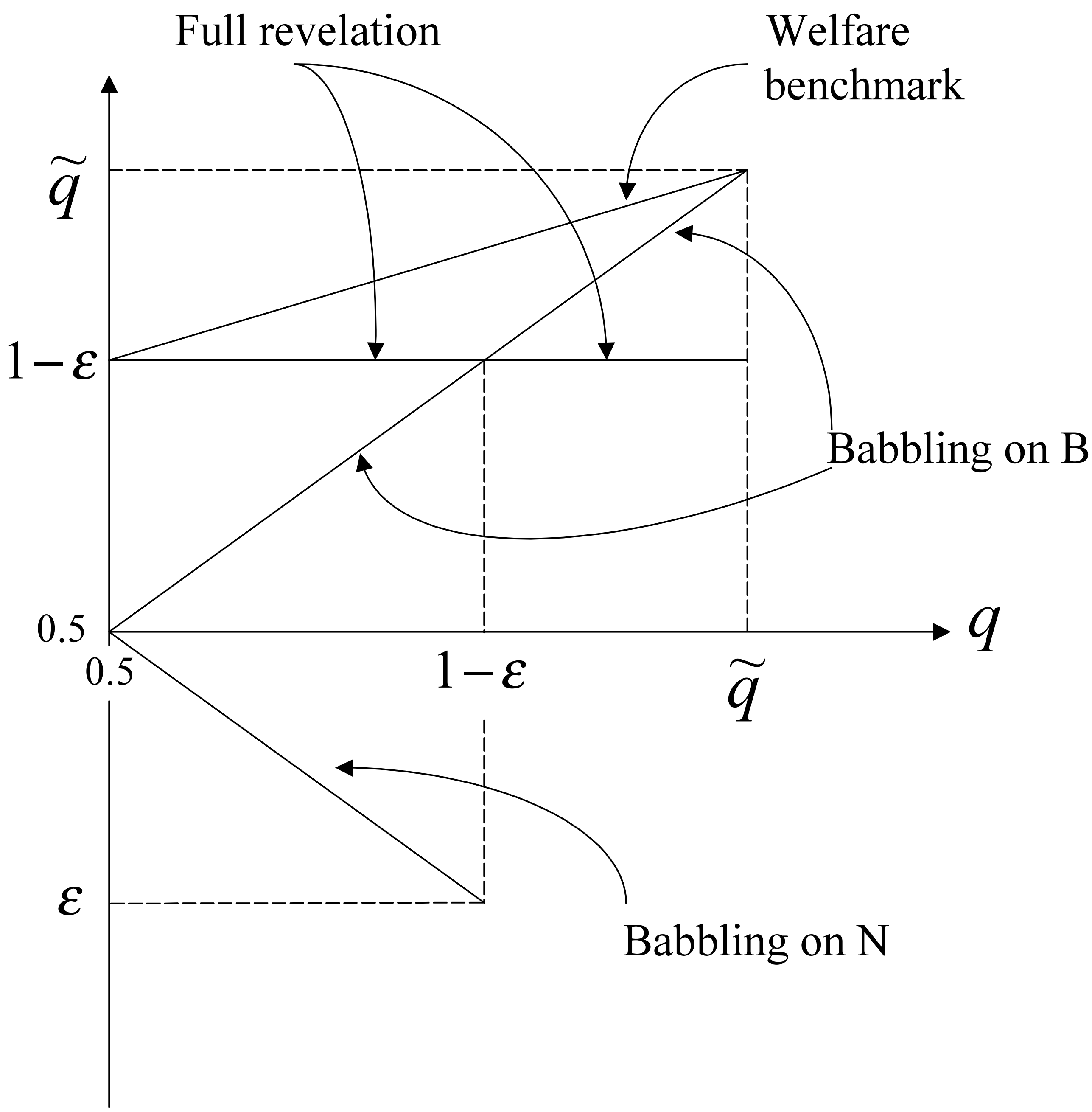
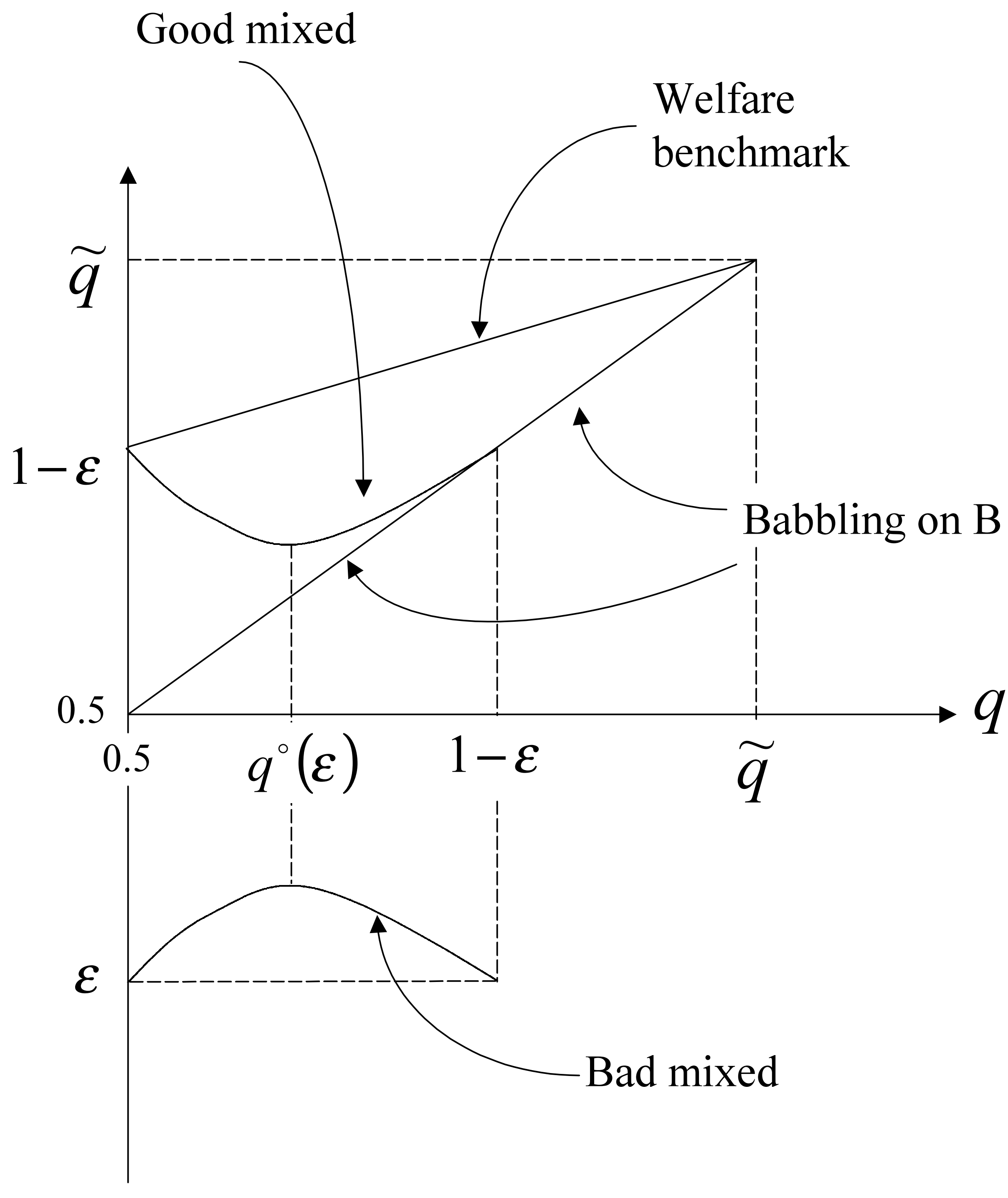
Figure 1



Full revelation
Welfare benchmark
$\tilde{q}$
$1-\varepsilon$
Babbling on B
0.5
0.5
$1-\varepsilon$
$\tilde{q}$
q
ε
Babbling on N

Figure 2



Good mixed
Welfare
benchmark
$\tilde{q}$
$1-\varepsilon$
Babbling on B
0.5
q
0.5
$q^{\circ}(\varepsilon)$
$1-\varepsilon$
$\tilde{q}$
ε
Bad mixed

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